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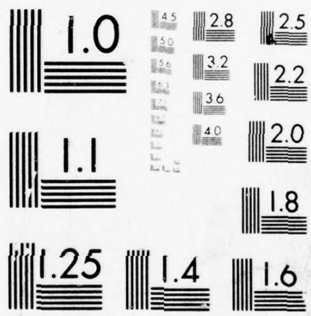

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Program LAU/OMENS2,R

F100PW100 (F-15/16)

Opportunistic Maintenance Engine Simulation Model

OMENS II

LEVEL IV

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This model simulates the operation of a single engine through a very long period of future time. In operating over this extended period, the engine must be removed for repair from time to time. Repairs become necessary on the engine when one of the modules fails prematurely or whenever it requires replacement of an internal life-limited part. The model tracks all the engine removals and all replacements of each module and offending life-

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limited part through future simulated time. Records are kept through simulated time of the number of removals and the reasons for removal for each module and for the engine. Reasons for removal include (1) premature failure of one or more parts, (2) reaching the scheduled operating time limit, or (3) being screened out due to the opportunistic maintenance policy. The model also computes maintenance, pipeline, parts costs, and transportation costs associated with the forecasted removals and aggregates the costs for any desired life cycle period (in years) to aid in selecting that optimal maintenance policy which produces the least total cost.

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SUMMARY

Program LAU/OMENS2,R

1. This Working Paper documents revisions to the old OMENS,R Computer Model (see Working Paper, OMENS 79-77-10).

2. OMENS2,R documents the CREATE Computer Program which simulates the operation of a single F100PW100 complete engine installed in an F-15 aircraft. It has improved and revised the original model, OMENS,R by adding the transportation costs involved in the maintenance of the F100 engine. An averaging table has also been added to average the seed runs if more than one seed run has been requested.

3. This model simulates the operation of a single engine through a very long period of future time. In operating over this extended period, the engine must be removed for repair from time to time. Repairs become necessary on the engine when one of the modules fails prematurely or whenever it requires replacement of an internal life-limited part. The model tracks all the engine removals and all replacements of each module and offending life-limited part through future simulated time. Records are kept through simulated time of the number of removals and the reasons for removal for each

module and for the engine. Reasons for removal include (1) premature failure of one or more parts, (2) reaching the scheduled operating time limit, or (3) being screened out due to the opportunistic maintenance policy. The model also computes maintenance, pipeline, parts costs, and transportation costs associated with the forecasted removals and aggregates the costs for any desired life cycle period (in years) to aid in selecting that optimal maintenance policy which produces the least total cost.

Chapter I

Background

1. The F100PW100 engine in the F-15 aircraft can be subdivided into modules. It is a relatively new engine concept in that each of the modules can be individually removed and replaced and each can therefore be replaced, purchased, stocked and repaired separately at various levels, each module as a single unit. There are six identifiable modules to date. They are the augmentor, inlet fan, fan drive turbine, core engine, gearbox and high pressure turbine. Each of these modules has a number of internal life-limited parts except the augmentor which has no life-limits. The engine has been broken into these modules to facilitate the removal and replacement actions and to manage the life limits on the parts. The total number of life-limited parts in the entire engine affected by the opportunistic maintenance policy is 41.

2. When the module is installed and operated as part of an engine, all the life-limited parts within that module age according to the flying hour rate of the engine. Management establishes limits on how many cycles (or sometimes, total operating time units) the parts in the modules may accrue

before they must be replaced. This maximum operating time (MOT) is normally stated either in cycles or total operating time (TOT) and converted into its engine flying hour equivalents within the model by applying an actuarial conversion factor set by engine management. In the examples shown in this program, the factor was set at the F100 Factors Meeting, 17 August 1978.

3. The life limits cause a management problem since they usually are not set at equal values across the parts. After one or more parts are replaced, the ages of the parts become mixed. Whenever a part reaches its life limit, the engine must be removed from the aircraft, and the engine must be put into maintenance where the module containing that part must be removed. If the parts ages are mixed, a large number of engine and module remove, replace, and repair actions is caused.

4. The opportunistic maintenance policy states that whenever an engine is removed for repair because of a problem within a module, all internal life-limited component parts of all the modules should be considered for possible replacement at that time, based on how close they are to their individual MOTs. This may cause the replacement of more than one module for each engine removal. When component parts are replaced

opportunistically, they no longer cause a near-future module (and corresponding engine) removal for that component replacement due to reaching its life limit. Thus, the number of future module removals for repair is greatly reduced while the number of spare parts used is increased. Preliminary studies have shown that the removal rates for the engine and modules can be reduced as much as 20 to 30% by appropriate selection of the opportunistic maintenance policy. See Working Note, XRS 77-7-1, November 1977, "A Study of the F-100 PW-100 Engine Maintenance and Build Policies."

5. This Working Paper will describe the logic and the computer program that simulates the operation of a single F100PW100 engine installed in an F-15 aircraft. The model will provide long-run forecasts of engine and module removals caused by failure as well as time expiration and opportunistic replacement of the internal life-limited parts. The model also calculates composite (both usage, scheduled, and screened) engine removals per 1000 flying hours factors and their corresponding NRTS rate factors. These forecasts will be based on appropriate input failure rates, MOT limits, and screening intervals being tested for the opportunistic maintenance policy. This model is a major tool for use in determining the expected effectiveness of alternate screening intervals, and its use will help the analyst in establishing effective policies for the F100 engine.

Chapter II

Need for the Model

1. When attempting to establish an effective opportunistic maintenance policy, one must determine how given screening intervals affect the future repair frequencies for the engine and its modules. A screening interval is a predetermined, definite time period immediately preceding an MOT limit. If a part's age falls within the screening interval when the module is in repair the part will be removed opportunistically at that time. In other words, if the part is close enough to its maximum operating time (MOT) at the time of a module repair, then it will be removed and replaced. This opportunistic action will preclude the later removal of the module merely to replace this part when it would finally reach its MOT. In general, as the screening interval is increased, more parts are screened out with each module removal and fewer module removals in total will occur over the given program period. At the same time, there will also be an increase in parts replacements since they would not have been permitted to reach their full lifetimes, having been screened out and replaced early. See Working Note XPS 77-7-1, "A Study of the F100 PW100 Engine Maintenance and Build Policies" for a graphic description of the impacts of an opportunistic maintenance policy using screening intervals.

2. This Opportunistic Maintenance Engine Simulation model -- OMENS II -- was developed in order to forecast future engine removals, module removals, individual parts replacements, and transportation costs as a function of the alternative screening intervals being tested for possible use in the opportunistic maintenance policy. The model becomes the calculator that helps the user assess the probable impact of each screening interval.

3. OMENS II simulates the operation of a single engine through a very long period of future time. In operating over this extended period, the engine must be removed for repair from time to time. Repairs become necessary on the engine when one of the internal components either fails prematurely, or reaches its maximum operating time. The model tracks through future simulated time all of the removals and replacements of the engine, the modules, and the internal component parts. Failure times are determined by making random number draws from lifetime distributions for each part. When new parts are installed to replace removed ones, a time to failure is determined for the replacement part and its future removal time is scheduled in the model. Records are kept through simulated time on the number of removals and the reason for removal for each part, each module, and the engine. Reasons for parts removals include premature failure, reaching MOT,

reaching tolerance, or being screened out due to the opportunistic maintenance policy. (Tolerance is the name assigned to an opportunistic removal of a part when it appears to be close to a failure. The aircraft mechanic would have the ability to identify impending failure of a certain portion of parts even if they were not near MOT, nor prematurely "failed" but worn and therefore in need of replacement).

Chapter III

Computation Logic

1. Program LAU/OMENS2,R is a Monte Carlo simulation model. It produces removals per 1000 FH for the engine and its modules, man hours expended, maintenance analysis and pipeline costs for the engine and modules, NRTS rates, parts costs, transportation costs, and total costs.

2. The main purpose of OMENS2,R is to calculate when in future simulated time each part will drive a module (and consequently engine) removal to replace the part. The part which fails or reaches its life limit is then replaced after making suitable records of the removal, and the time until next removal for the replacement is determined by making a random draw from the time-to-failure distribution for that part. While the engine (or module) is in repair, all of the other modules (or parts) which have not failed are screened to see whether they are close enough to their maximum operating time (MOT) limits so that it is economical to replace them at this time. If a part is screened out, records are updated recording which part was replaced and why, a replacement part is then installed and its time to next failure is established by a random number draw exactly the same as was done above for a failure. The removals of the next higher assembly module and/or engine are also recorded by the model.

3. The model maintains two counters for each life-limited part. One counter, JTTF(J), keeps track of time remaining (in flying hours) until part J is forecasted to be removed because of premature failure. The other counter, JTTL(J), keeps track of how much time remains until part J would reach its maximum operating time. The maximum operating time is stated in the input in either total operating time units or in cycles both of which are converted to engine flying hours by an actuarial conversion factor.

4. The simulation clock is advanced in the following way. After all the failure times (JTTF(J)'s) and MOT times (JTTL(J)'s) have been established for all J parts, the program finds the minimum JTTF(J) and the minimum JTTL(J), and the lesser of these values is selected. This is the time until the next most imminent event. The next steps in the program determine whether this minimum occurs in the current report period and whether on one or more than one part. That is, will there be multiple part failures, and will they occur in the present or a future reporting period?

5. Following the determination of the next most imminent event, this amount of time is subtracted from every JTTF(J) and JTTL(J) and from the time remaining until the end of the report period, and it is added to the system clock. The

subtractions are done for one J part at a time and the addition is done once per engine removal. After all the parts have been updated, reasons for the removals of the parts are determined. If a part failed prematurely, it is classified into one of two categories: (1) a usage removal if its time remaining until MOT, JTTL(J), is greater than its screen or (2) a U-Dep (usage to be repaired at depot) removal when its time remaining until MOT, JTTL(J), is less than or equal to the screen. If a part did not fail but its time remaining is less than or equal to its tolerance interval, it is also considered as a failure and is removed. Tolerance removals are those parts removals that are expected to be detected by maintenance personnel because they are about to fail and some symptom will be noticeable. If JTTL(J) is equal to zero, this means that there is no time remaining until MOT and the removal is classified as an MOT removal. If the time remaining is greater than zero but is less than or equal to the screen interval, the part is classified as screened out.

6. Following the appropriate tabulations of the removal of part J, the modules containing the offending parts are identified by removal codes. There is a hierarchy involved in multiple parts removals from the same module. If multiple

parts are removed, all for usage reasons, the module is declared a usage removal. If the module removal involved a mixture of MOT part removals and usage part removals, the module is classified as multiple parts with at least one scheduled removal.

7. After completion of module removal classifications, another portion of the program is entered to determine the engine removal disposition and code. This part of the program adds up the number of modules removed to determine if the engine is to be NRTS to depot as a whole-up engine or not. The logic is stated as follows: if there are four or more offending modules, excluding the augmentor and accessories-2 but including the core, the engine is NRTS to depot. This is called the Rule of 4 Policy. Since this logic is not firm, the program enables the user to test for different values other than 4 and so the policy is often referred to as the Rule of X, where X is limited to the maximum number of modules involved in the engine.

8. The next portion of the program tallies all of the removals for parts, modules, and complete engine and records the disposition of each. This enables the output tables to be processed showing engine removals, what modules drove the

removals and what parts drove the modules. Repair dispositions are also determined here, i.e. whether the modules are repaired at base or depot.

9. The process described above is carried on until the entire simulation period, ISIMYRS (input by the user), is reached. Output showing the number of screened out parts by module and the disposition of the modules is made periodically throughout the run according to the report period, ISIMPRD, defined at input time. Other more detailed output is described later in this Working Paper.

Chapter IV

Input

1. The LAU/OMENS2,R program consists of two other files needed for a simulation run. The main file contains the program logic and the internal data. This file is named LAU/OMENS2.S and is the source program file. The internal data in this program contains all the names and indices of the engine and its modules and all the various life limited parts. This data also has all the actuarial, pipeline, and cost factors associated with each component. These values such as NRTS rates, removal rates, cycle, TOT or engine flying hour limits, and costs are those given in the Design Maintenance Concept or in various other official projections approved by HQ AFLC/LOP, Wright-Patterson AFB, Ohio 45433. The values will be discussed in detail in Chapter VI. The program logic and the internal data combine to form the OMENS2.S file as previously stated. This file is then compiled into an object deck named OMENS2.O. This object file is a binary object deck of the source program (OMENS2.S). It is already compiled so the program does not have to recompile every time a simulation run is needed.

2. The file that is most important to the actual run has read permission and is called LAU/OMENS2.R,R. This file is listed here to aid in the explanation of the variable input allowed.

```

           OMENS2.R


     1##NORM,ROUT(AC)

     3$:IDENT:WP1271,XRSL/PERSENSKY      OMENS2.R
     4$:OPTION:FORTRAN,NOMAP
     5$:SELECT:LAU/OMENS2.O
     7770$:EXECUTE
     7772$:LIMITS:3,,,5K
     7776$:DATA:I*
     7777#4,0,450,450,450,450,450,450,450,450,3,0,1,1,15,200,17
     9999$:ENDJOB

```

a. <u>The Variable Input</u>. This input is found in line 7777. This line contains a line of data with input that can be changed by the program user as appropriate. Each entry is discussed below in the order the input must be entered.

(1) <u>M Rule</u>. The first entry in the data line should be the X value for the policy Rule of X. This Rule of X states how many modules must be in need of repair before they are sent to the depot together as an engine NRTS. If 4 is used as in the example below, then 4 modules (including the core and excluding the augmentor and accessories-2) must be in need of repair in order to necessitate an engine NRTS.

Example. 7777#4,0,450,450,450,450,450,450,450,450,3,0,1,1,15,200,17

(2) KPI. This is the second entry in the data line. It is the constant or percent indicator for the screen. It can take on only one of two values. If a constant screening value is desired, as in the example below, then a 0 should be entered. If the screen desired is a percent of the maximum operating time, a 1 should be entered.

Example. 7777#4,0,450,450,450,450,450,450,450,450,3,0,1,1,15,200,17

(3) KPV(I),I=1,8. The next eight values represent the screens for the eight modules. They are either constant screening values or screening values expressed as a percentage of MOT, whichever is desired. The field should always be three numeric characters. If a constant 450 screen is desired for each module as in the example below, eight 450 values, separated by commas, should be input. If a 10 percent of maximum operating time (MOT) screen is desired for each module, eight 010 values, separated by commas, should be input. No constant screen greater than 999 or percent screen greater than 100 will be accepted as valid input.

Example. 7777#4,0,450,450,450,450,450,450,450,450,3,0,1,1,15,200,17

A different screening value for each module is allowed, but the screens must all be either constant values or percent of MOT values.

The module order for variable screen entries is dictated in the program logic. Eight values are needed for a screening policy, whether or not they are variable screen values. The first screen value entry is assigned to the augmentor, the second is assigned to the accessories-1, and so on, through all eight identified modules. The complete module order is:

(a) Augmentor
(b) Accessories-1 (with life limits)
(c) Fan
(d) Core
(e) High pressure turbine
(f) Fan drive turbine
(g) Gearbox
(h) Accessories-2 (without life limits)

(4) ISMAX. This is the next entry in the data line immediately following the eight screen values. It is the total number of runs desired, and it can take on any value from 1 through 9. This value determines how many simulation runs will be made under one program run with the same data in line 7777. In the following example, the value is 3.

Example. 7777#4,0,450,450,450,450,450,450,450,450,3,0,1,1,15,200,17

(5) <u>IP</u>. This is the next entry in the data line. It is the print indicator and dictates either a long or short form of printout from the simulation run. If a complete long printout is desired a 0 should be used as in the example below. If a summary or short form printout is desired, a 1 should be used.

Example. 7777#4,0,450,450,450,450,450,450,450,450,3,0,1,1,15,200,17

(6) <u>KS</u>. This next entry indicates if a standard or random seed is desired. If a standard seed is desired a 0 should be used. It should be noted here that if a standard seed is used there is no point in generating more than one identical seed run and thus the ISMAX entry (discussed in number 4 above as how many runs are desired) should be a 1. If a random seed is desired as in the example shown below, a 1 should be used.

Example. 7777#4,0,450,450,450,450,450,450,450,450,3,0,1,1,15,200,17

(7) <u>KW</u>. This entry dictates whether or not warmup is desired. If it is desired to have all the parts start out the simulation with 0 accumulated age (new parts) a 0 should

be entered. If warmup is desired (a random mixture of parts ages to start the simulation) a 1 should be input as in this example.

Example. 7777#4,0,450,450,450,450,450,450,450,450,3,0,1,1,15,200,17

(8) LFCYC. This two-position entry is the life cycle value in years used to compute the objective function, i.e. the cost function over a particular life cycle period. In the example below, 15 years is illustrated.

Example. 7777#4,0,450,450,450,450,450,450,450,450,3,0,1,1,15,200,17

(9) SIMYRS. This entry is the number of simulation years desired for the program run. In the example below 200 years is used. The entry must be three positions.

Example. 7777#4,0,450,450,450,450,450,450,450,450,3,0,1,1,15,200,17

(10) MONUTR. This is the last data line entry and stands for the monthly utilization rate desired on the engine in flying hours. In the example below, 17 flying hours per month is used. The entry must be two positions.

Example. 7777#4,0,450,450,450,450,450,450,450,450,3,0,1,1,15,200,17

b. The RUN Command. Following the variable input changes as appropriate, the user must input the run command and await the output as explained in the following chapter.

c. It should be noted that the program is built to produce ten report periods. The simulation period is produced by taking the simulation years (SIMYRS), multiplying by the monthly utilization rate (MONUTR), and multiplying that by 12 (months/year). Then this simulation period is divided by ten to yield ten report periods of equal length. To change the number of report periods, the source program must be changed and recompiled. This cannot be done without consulting the programmer of OMENS II.

3. For further introduction and instructions on running OMENS2.R, the user should log on a terminal and call for a listing of OMENTEXT,R. It can be retrieved under SYSTEM? YFORT OLD OMENTEXT,R. At the ready * level the user should simply type LIST.

Chapter V

Output

1. The complete output from a run of program LAU/OMENS.R,R is in several sections as follows:

   a. Cross Reference Table.

   b. Engine Removals Report Period Summary.

   c. Engine NRTS Analysis.

   d. Module Removals Report Period Summaries.

   e. Module Removals Summary.

   f. Parts Removal Summaries.

   g. Objective Function - Engine.

   h. Objective Function - Modules.

   i. Life-Limited Parts Replacements Costs.

j. Objective Function Summary.

k. Screen, NRTS rate and Removals Per 1000FH Summary.

l. Averages Summary.

m. Actuarial Input Data.

2. Sections (a) through (k) inclusive will be printed as output if the long printout is requested. If the short form printout is requested, sections a, b, c, e, j, and k are printed as output. Individual output sections are discussed in the following paragraphs.

3. Cross Reference Table. This table shows the index number corresponding to the module, screen interval values in either constant or percent form, equivalent value in engine flying hours, and equivalent months. See Table 1.

a. Module Number. This is the numerical index assigned to the module for order purposes. The modules will keep these same indices throughout the printout.

b. Module Nomenclature. This is the module name as it will appear and be referred to throughout the printout.

c. Constant or % of MOT. This nomenclature choice is dictated by the user before the run, depending on whether a constant or percent of MOT screen is chosen. If a constant

screen is chosen the constant screen value will appear here. If a percent of MOT is chosen the percentage appears here.

d. Screen Interval. This column will duplicate the screening value in c. above if a constant is used. Otherwise the percent of MOT is figured and its value will appear here.

e. Screen in EFH. This value takes the screen interval and converts it to equivalent engine flying hours using an appropriate conversion factor.

f. Months Remain. This column is a computed value in terms of months showing how many months of life are being sacrificed by the screening value chosen. It is computed by taking the screening value in engine flying hours and dividing it by the monthly utilization rate for the engine. See Chapter IV, 2.a.(10).

g. Rule of X was ____. This footnote appears directly below the Cross Reference Table and is simply a reminder of the Rule Policy value chosen before the RUN command. See Chapter IV, 2.a.(1) for further explanation of the Rule of X.

4. Engine Removals Report Period Summary. This table shows which seed run is being reported, the simulation period and report period chosen, the life cycle period and monthly utilization rate desired, whether or not warmup and random seeds were used for the run, the number of modules involved and the Rule of X value. It also displays an input engine NRTS rate and removals per 1000 FH and computed outputs for these two terms. The chart immediately following this shows by report period how many and which modules failed or reached MOT causing an engine removal. See Table 2.

a. Report Period K. This K value tallies how many report periods were desired in the simulation run.

b. Report Period Hours. This value is the amount of engine flying hours that have been reached since the first K report period started. It is cumulative so that its last value equates to the value chosen for the entire simulation run.

c. One Module Fails Early. This column tallies how many times an engine was removed due to a single module failure.

d. Many Modules (Fail) Early. This column tallies how many times an engine was removed due to multiple module failures.

e. Many Modules U + T. This column records how many times an engine was removed due to a combination of usage and time (MOT) module removals for failures and scheduled checks respectively.

f. One MOT Reached. This column records how many times an engine was removed due to a single scheduled module removal.

g. Total. This column now adds the other columns up row-wise for a total by report period.

h. Totals. This line appears at the bottom of the table and adds each column for a total of the different removal reasons listed and a grand total on the far right under the Total column described in (g) above.

5. Engine NRTS Analysis. These tables appear on page three of the printout. Table 3 displays a distribution of modules removals that were NRTS to the depot as single modules and Table 4 shows those that were NRTS as part of the engine Rule of X Policy. See Table 3.

a. Item. This column displays which module (by item number) is involved.

b. Base RTS. This column shows which modules did not get sent to the depot as lone modules but were classified as base repairs.

c. Initial NRTS Percent. This column displays input NRTS % rates as established by management.

d. Usage NRTS. This column gives the total number of times during the simulation run that each module was removed and NRTS as a lone module for usage purposes. It is computed by comparing a random number to the initial NRTS percent for each module. If the random number is less than or equal to the NRTS % the module is considered to be NRTS. If the random number is greater than the NRTS % the module is considered to be Base RTS.

e. U-Screen NRTS. This column shows the total number of times during one complete simulation run that each module was removed for usage and at the same time found to be within its screening interval and thus NRTS as a lone module.

f. Scheduled NRTS. This column gives the total number of times during one complete simulation run that each module was removed and NRTS as a lone module for scheduled purposes, i.e. reaching its life limit.

g. Screen NRTS. This is the seventh column in the table and it records the total number of times each module was removed and NRTS alone for screening reasons.

h. Total NRTS. This column adds up all the NRTS alone categories for each module and shows the total of the NRTS alone removals by module.

i. Final NRTS Percent Alone. This column lists the final NRTS percent for each module (those not part of the engine Rule of X Policy). It takes the total NRTS alone removals and divides that number by the base RTS plus the total NRTS removals for each module.

j. Removals Per 1000 FH. This is the last column of the first table. It records the final removal rate for lone modules by adding the RTS plus total NRTS alone and dividing this total by the simulation period and multiplying by 1000 to get removals per 1000 FH.

6. Engine NRTS Analysis, NRTS with Engine NRTS Policy. This table shows similar information as in Table 3, except all the modules were part of the engine NRTS due to the Rule of X Policy, where X was determined at the beginning of the simulation run. See Table 4.

a. Item. Number assigned to the module involved. Statistics are read by row.

b. Usage NRTS. This column records all the usage removals of modules that went to the depot as part of the engine due to the Rule of X Policy.

c. U-Screen NRTS. This column records by module which removals were for usage and at the same time were found to be eligible to be screened out. These modules would therefore be NRTS. However, they are part of the engine Rule of X Policy so they become classed as an engine NRTS and are not counted as module NRTS.

d. <u>Scheduled NRTS</u>. This column gives the total number of times during the simulation run that each module had reached its MOT, but was sent to the depot as part of the Rule of X Policy and removed there.

e. <u>Screen NRTS</u>. This is the fifth column shown in this table. It records the total number of screened modules that were sent to the depot as part of the complete engine for removal and repair at the depot level.

f. <u>Total NRTS</u>. This adds the total number of module removals for cause that occurred at depot as a result of going with the complete engine because of the Rule of X Policy.

g. <u>Not Effected But NRTS</u>. This last column records how many times good modules were sent to the depot as part of a whole engine due to the Rule of X Policy. These modules were not effected by malfunctioning, reaching MOT, or screening and otherwise would not have been removed or repaired as a separate module. These modules are simply "going along for the ride" as part of an engine NRTS.

h. <u>Total</u>. This line simply adds up how many total modules were sent to the depot as engine NRTS for the various removal reasons explained above.

i. <u>Total Engine NRTS</u>. This line shows how many times the engine was considered NRTS due to the Rule of X Policy.

j. <u>Engine NRTS Percent</u>. This is the percent of engine removals that were NRTS to the depot as part of the Policy.

k. <u>Total Removals Per 1000 FH</u>. This line calculates the total number of engine removals per 1000 FH by taking the total number of removals and dividing by the total number of flying hours in the simulation run and multiplying the result by 1000.

7. <u>Module Removals Report Period Summary</u>. The next set of tables shows module removal summaries on a separate table for each module. Each table is alike so the following description appears only once and applies to all Module Removals Report Period Summary Tables. The core is used as an example on Table 5. The heading entries are self-explanatory.

a. <u>Report Period K</u>. This K value identifies each period by number.

b. <u>Report Period Hours</u>. This value is the amount of engine flying hours that have been reached since the first K report period started. It is cumulative so that its last value equates to the value chosen for the entire simulation run.

c. <u>One Part Fails Early</u>. This column tallies how many times the module was removed due to a single part failure.

d. <u>Many Parts (Fail) Early</u>. This column tallies how many times the module was removed due to multiple part failures.

e. <u>Many Parts U + T</u>. This column records how many times the module was removed due to a combination of usage and time (MOT) part removals for failures and scheduled checks respectively.

f. <u>One MOT Reached</u>. This column records how many times the module was removed due to a single scheduled part removal.

g. <u>Parts Screened Out</u>. This column records how many times a part was screened out of the module opportunistically during the report period K.

h. <u>Total</u>. This column adds the other columns up row-wise for a total by report period of parts removals.

i. <u>Totals</u>. This line appears at the bottom of the table and adds each column for a total of the different parts removed as listed and a grand total on the far right under the Total column described in (h) above.

j. Removals Per 1000 EFH. This line is followed by input base removals and computed output base, depot and total removals per 1000 EFH.

k. NRTS Percent. This line is followed by input base level NRTS and computed base level, depot level and total NRTS percent.

l. Percent Depot Repair. This line compares the total number of depot removals with the total number of removals for cause and yields percentages respectively.

8. Module Removals Summary. This table shows the removal reasons for each module and how many times each was removed due to the parts needing replacement. See Table 6.

a. M. Number assigned to module involved.

b. Module Nomenclature. Name assigned to module involved. These names are used throughout the printout.

c. Use. This column shows how many times each module was removed due to a failure of one of its parts.

d. U-Dep. This column records usage removals that also qualified to be screened and shows which modules had parts removed and how many were removed.

e. Time. This column tallies which modules were removed due to scheduled parts replacements and how many were removed.

f. Screen. This column records screened parts removals, showing how many were screened and from which modules.

g. Total. This column totals parts removals by module.

h. Screen Interval. This column shows the screen interval used, whether it was constant or percent of MOT.

i. Grand Total. This row totals the individual columns and gives a grand total at the far right.

9. Parts Removal Summary. This set of tables shows parts removal summaries, one table per individual module. Each table shows all the life-limited parts in the module as well as the "dummy" part. The dummy part accounts for all the premature removals experienced by the module. All the reasons for removals are shown for each part. The value of the screen interval, whether originally input as a percent of MOT or a constant is also shown. The core module is used as example in Table 7.

a. Part No. J. Number assigned to part involved.

b. Part Name. Self-explanatory.

c. Usage Removals. This column records all the parts removed for usage purposes on the module.

d. Tolerance Removals. This column records removals of parts that were so close to failure that signs of wear dictated their premature removals (before they actually failed or reached MOT).

e. U-Dep Removals. This column records parts usage removals that also qualified to be screened.

f. Time Removals. This column records all parts removed due to reaching their life limits.

g. Screen Removals. This column records screened out parts in the module.

h. Total. This column totals parts removals by module.

i. Percent of MOT. This column, when headed by the word CONSTANT, shows the constant screen applied to each part. The heading % OF MOT SCREEN shows the actual screen interval value of the % of MOT.

j. Module Totals. This row totals up the number of each type of module removal that ensued due to a part needing repair or replacement.

10. Objective Function - Complete Engine Maintenance Costs. The objective function relates input cost data to computer generated engine removals data to assign maintenance and pipeline costs to the chosen life-cycle period. See Table 8.

a. Total NRTS Engine Removals. This value is previously computed based on the Rule of X chosen.

b. *"LFCYC"/"SIMYRS". These values are inputted by the user before the run. The desired life cycle divided by the total number of simulation years becomes the factor needed to scale down the total NRTS removals to a life cycle's worth.

c. Depot Cost/Engine. This input value is the average depot repair cost experienced by San Antonio ALC.

d. Total Base Engine Removals. This value is previously computed and is found by simply subtracting the NRTS engine experienced in the run from the total engine removals in the run.

e. *"LFCYC"/"SIMYRS". See Item (b) above.

f. Base Cost/Engine. This input value is the average base cost to repair each engine at the base level.

g. Total "Life Cycle" Years Depot and Base. This column is computed by multiplying 15 years worth of NRTS removals times the average depot repair cost and adding this to the 15 years worth of base removals times the average base cost per engine.

11. Objective Function - Module Maintenance Cost With. See Table 8, bottom.

a. Item. This column displays which module (by item number) is involved.

b. Module Nomenclature. This column denotes the name and number assigned to the different modules in the program simulation.

c. Total NRTS Module Removals. This number is the total NRTS modules that were NRTS as part of the engine Rule of X Policy.

d. *"LFCYC"/"SIMYRS". These values are inputted by the user before the run. In general, the value computes a life cycle from a particular simulation period. Both the life cycle length and the total simulation period are chosen by the user before the run is made.

e. Depot Cost Factor. This value is input data internal to the program. It is the average remove and replace cost for each item (module) at the depot level.

f. Total "Life Cycle" Years Depot. This value is computed for each module by multiplying the life cycle value of NRTS removals for each module times the depot cost factor, yielding a total life cycle's worth of costs by module for depot repair.

g. Total. This value cumulates the total life cycle cost at the depot for each module and yields a total additional cost to the depot engine repair cost for the same life cycle period.

12. Objective Function - Complete Engine Pipeline Costs. See Table 9.

a. Daily Demand Rate.

(1) Removals/1000 FH. This value is the final removals per 1000 flying hours for the engine computed in the simulation run. It is used here to determine the daily demand rate in conjunction with the conversion factor below.

(2) *"MONUTR"/30000. This value is multiplied times the removals per thousand hours to compute a daily demand rate. Monutr is a term meaning monthly utilization rate and is input by the user at the beginning of the run. Thus, the removals/1000 FH multiplied by, say 17 flying hours per month is:

$$\frac{\text{REMOVALS}}{\text{1000 FH}} * \frac{17}{30} = \text{DAILY DEMAND RATE}$$

b. NRTS Rate. This is the percentage value of engine removals that were NRTS to depot divided by the total number of engine removals.

c. NRTS Pipe. This column lists the input standard depot pipeline repair days for the engine.

d. Base Rate. This is the percentage value of engine removals that were repaired at base divided by the total number of engine removals.

e. Base Pipe. This value is input data internal to the program and shows the standard base pipeline repair days for the engine.

f. Pipeline Quantity. This value is computed by taking the daily demand rate and multiplying it by the percentage of NRTS engines times its standard depot pipeline repair time plus the percentage of base repaired engines times its standard base pipeline repair time. The equation is:

$$\text{PIPELINE QUANTITY} = \text{DAILY DEMAND RATE} \left[\left(\frac{\text{NRTS RATE}}{100} * \text{NRTS PIPE} \right) + \left(\frac{\text{BASE RATE}}{100} * \text{BASE PIPE} \right) \right]$$

g. Stock List Price. This value is inputted and is the approximate procurement cost in today's dollars of an F100PW100 engine.

h. Total Cost. This is a computed value found by multiplying the pipeline quantity times the stock list price.

13. Objective Function - Module Maintenance Costs Alone. See Table 10.

a. <u>Item</u>. As previously noted.

b. <u>Total NRTS Module Removals</u>. This column records the total amount of module removals (by module) that needed depot level repair and were sent as a separate unit rather than with the whole engine.

c. <u>*"LFCYC"/"SIMYRS"</u>. These values are user inputted at the beginning of the run. It is used to scale down total removals for the entire simulation period to a life cycle's worth of removals. This is done by multiplying the total removals by the factor consisting of the life cycle divided by the total number of years in the simulation.

d. <u>Depot Cost Factor</u>. This column lists input data that was computed by averaging the amount of manhours spent to repair each module at the depot. Then a cost per manhour factor was applied to obtain the average depot cost per module. Then this factor is carried in the input data.

e. <u>Total Base Module Removals</u>. This column records the total amount of times each module was removed and repaired or replaced at base level.

f. *"LFCYC"/"SIMYRS". See Item 13(c) above.

g. Base Cost Factor. This column shows input data that was computed by averaging the amount of manhours spent to repair each module at the base. Then a cost per manhour factor was applied to obtain the average base cost per module.and this factor is carried in the input data.

h. Total "LFCYC" Years Depot and Base. This column obtains its values by taking the life cycle's worth of depot removals times the depot cost factor and adding to this value the life cycle's worth of base removals times the respective base cost factor.

14. Module Pipeline Costs. This table shows the pipeline cost breakdown incurred by module. See Table 11.

a. Item. As explained previously.

b. Daily Demand Rate.

(1) Removals/1000 FH. These values are the final removals per 1000 flying hours computed in the simulation run for each module.

(2) *"MONUTR"/30000. This value is multiplied times the removals/1000 FH above to compute a daily demand rate. Monutr means monthly utilization rate and is user inputted at the beginning of the run. It is divided by 30,000 because there are approximately 30 days per month and the removal rate is given per 1000 FH, hence 30 * 1000 = 30000.

c. NRTS Pipe. This column lists the standard depot pipeline repair days for each module.

d. Base Pipeline. This column lists the standard base pipeline repair days for each module.

e. Pipeline Quantity Per Module. This column finds the fraction of depot removals times the depot pipe and adds to it the fraction of base removals times the base pipe and then multiplies this sum by the daily demand rate for each module.

f. Module Price. This value is inputted and is the approximate procurement cost in today's dollars of each module.

g. Cost Per Module. This value is computed for each module by multiplying the respective pipeline quantity times the module price.

15. Transportation Costs. This table shows the transportation costs incurred by modules when sent alone and by entire engines when sent to the depot for repair. See Table 11 (a).

a. Item. Self-explanatory.

b. Nomenclature. Self-explanatory.

c. NRTS Removals. This column records the total amount of module removals by module and by engine that needed depot level repair and were sent as a separate unit or as an entire engine with separate transportation costs applied.

d. *"LFCYC"/"SIMYRS". These values are user inputted at the beginning of the run. It is used to scale down total removals for the entire simulation period to a life cycle's worth of removals. This is done by myltiplying the total removals by the factor consisting of the life cycle divided by the total number of years in the simulation.

e. Transportation Cost/Removal. This value is data internal to the program. It was found by taking a weighted average of removals occurring at various bases -- the cost of sending the item to the depot from each location is known -- and computing an average transportation cost for the engine and each module.

f. 15-Year Costs. This figure is found by multiplying the average transportation cost per removal by the 15-year average NRTS removals found in the fourth column.

16. Life-Limited Parts Replacement Costs for a Particular Life Cycle. These tables are alike and show parts replacement costs for a user-inputted life cycle by module. Since the chart is repeated for each module, Table 12 shows an example chart for the core module.

a. Part Number. The number assigned to the life-limited and "dummy" parts identified in the simulation.

b. Part Name. Self-explanatory.

c. Total Scheduled Removals ("SIMYRS"). This column shows the total number of scheduled removals for the entire simulation for each part shown.

d. Scheduled Removals ("LFCYC"). This column shows the fraction of scheduled removals that took place during the desired life cycle input by the user.

e. Unit Price. This column shows the average stock list price for each part.

f. Total "LFCYC" - Year. This column multiplies the Scheduled removals in the chosen life cycle times the unit price to yield parts replacement costs for each part during the desired life cycle period.

17. Objective Function Summary. This table pulls together the maintenance costs, pipeline costs, and parts costs to yield a total cost of operating one engine for the entire life-cycle period. See Table 13.

a. Item Name. Self-explanatory.

b. Maintenance Costs.

(1) Alone. These are maintenance costs incurred by the individual modules when serviced alone and not as part of an engine NRTS. Base and depot costs are separated here also.

(2) With. These are maintenance costs incurred by the modules when they were part of an engine NRTS policy.

(3) Totals. This column simply adds maintenance costs alone with maintenance costs with engine NRTS policy.

c. Pipeline Costs. These values were previously computed and defined in the simulation.

d. Transportation Costs. As previously recorded.

e. Parts Costs. As previously recorded.

f. Total Costs. This column simply sums the maintenance costs, pipeline costs, and parts costs by module, and by module totals and finally row-wise for a grand total on the far right.

18. Screen, NRTS Rate and Removals/1000 FH Summary. See Table 14.

a. Item Name. Self-explanatory.

b. Screen Interval. This value is the constant or percent of MOT value in engine flying hours.

c. Initial NRTS Rate %. This column is data internal to the program.

d. Initial Rem/1000 FH. This column is also data internal to the program as defined in the Design Maintenance Concept.

e. Final NRTS Rate %. This column recaps the output NRTS rate percent computed in the simulation.

f. Final Removals Per 1000 FH. This column recaps the output removals/1000 FH computed in the simulation run.

19. Average Data. The average data is found in Table 15. This section of the program averages the data obtained from the seed runs (if greater than one run was requested). The engine removals by report period summary,modules removals summary, objective function summary, and final NRTS rate and removals per 1000FH are all averaged as shown in the table. Each summary has been previously explained in this section.

20. Actuarial Input Data. This data is internal to the program and is printed out for the benefit of the user. The data is explained in the printout.

Table 1.

SEED RUN 3 >> CROSS REFERENCE TABLE << PAGE 1

F100PW100(F15)

DATA 061879 TIME 11.46 SEC 24

MODULE NO.	MODULE NOMENCLATURE	CONSTANT SCREEN	CONSTANT INTRVL	SCREEN IN EFH	MONTHS REMAIN
1	700 AUGMENTOR	100	100	100.0	5.88
2	100 ACC1 WLL	100	100	62.5	3.68
3	300 FAN	100	100	45.5	2.67
4	400 CORE	100	100	45.5	2.67
5	500 H P TURB	100	100	45.5	2.67
6	600 FAN DR TUR	100	100	45.5	2.67
7	800 GEARBOX	100	100	62.5	3.68
8	900 ACC2 WOLL	100	100	100.0	5.88

RULE OF X WAS 4

Table 2.

ENGINE REMOVALS PAGE 2

REPORT PERIOD SUMMARY

F100PW100 (F15)

SEED RUN 2

	INPUT	OUTPUT
REM/1000FH	4.7000	12.5735
NRTS %	4.70	1.17

SIMULATION PERIOD IS 40800
REPORT PERIOD IS 4080
LIFE PERIOD FOR OBJECTIVE FUNCTION IS 15 YEARS
MONTHLY UTILIZATION RATE IS 17 FLYING HOURS
WARMUP YES
SEED IS RANDOM
NUMBER OF MODULES 8 RULE OF X WAS 4

ENGINE REMOVALS

REPORT PERIOD K	HOURS	* * USAGE * * * ONE MOD. FAILS EARLY	MANY MODS. EARLY	... TIME ... MANY MODS. U+T	ONE NOT REACHED	TOTAL
1	4080	8	0	32	14	54
2	8160	10	1	26	21	58
3	12240	10	0	24	14	48
4	16320	8	1	27	14	50
5	20400	4	0	28	18	50
6	24480	8	0	31	11	50
7	28560	12	0	31	10	53
8	32640	8	0	25	16	49
9	36720	7	1	24	15	47
10	40800	8	0	29	17	54
TOTALS		83	3	277	150	513

Table 3.

ENGINE NRTS ANALYSIS PAGE 3

DISTRIBUTION OF MODULE REMOVALS

(NRTS RETURN TO DEPOT ALONE)

ITEM	BASE RTS	INITIAL NRTS%	USAGE NRTS	U-SCREEN NRTS	SCHED NRTS	SCREEN NRTS	TOTAL NRTS	FINAL NRTS % ALONE	REM/ 1000FH
1	48	9.00	2	0	0	0	2	4.00	1.2255
2	0	0.	0	0	87	68	155	100.00	3.7990
3	3	56.00	5	0	69	51	125	97.66	3.1373
4	0	85.00	4	0	110	72	186	100.00	4.5588
5	1	70.00	3	0	94	20	117	99.15	2.8922
6	2	53.00	4	0	43	17	64	96.97	1.6176
7	0	77.00	1	0	10	20	31	100.00	0.7598
8	137	0.	0	0	0	0	0	0.	3.3578
TOTAL	191		19	0	413	248	680		

Table 4.

DISTRIBUTION OF MODULE REMOVALS

NRTS WITH ENGINE NRTS POLICY

ITEM	USAGE NRTS	U-SCREEN NRTS	SCHED NRTS	SCREEN NRTS	TOTAL NRTS	NOT AFFECTED BUT NRTS
1	0	0	0	0	0	6
2	0	0	1	4	5	1
3	0	0	1	4	5	1
4	0	0	1	5	6	0
5	0	0	3	0	3	3
6	0	0	0	4	4	2
7	0	0	0	2	2	4
8	1	0	0	0	1	5
TOTAL	1	0	6	19	26	22

TOTAL ENGINE NRTS 6
ENGINE NRTS % 1.17
TOTAL REM/1000FH 12.5735

MODULE REMOVALS PAGE 7
REPORT PERIOD SUMMARY

400 CORE

SEED RUN 2
SCREEN IS 100; TYPE IS CONSTANT
NUMBER OF PARTS 22
MONTHLY UTILIZATION RATE IS 17
REPORT PERIOD IS 4080

MODULE REMOVALS (ALONE + NRTS WITH ENGINE)

		* * USAGE * * *		... TIME ...			
	REPORT PERIOD K HOURS	ONE PART FAILS EARLY	MANY PARTS EARLY	MANY PRTS U+T	ONE NOT REACHED	PARTS SCREENED OUT	TOTAL
	4080	1	0	1	10	10	22
[illegible]	8160	0	0	2	11	6	19
3	12240	1	0	4	5	7	17
4	16320	0	0	1	10	8	19
5	20400	0	0	3	9	5	17
6	24480	2	0	3	4	11	20
7	28560	0	0	3	9	6	18
8	32640	0	0	1	11	10	22
9	36720	0	0	2	7	9	18
10	40800	0	0	2	13	5	20
TOTALS		4	0	22	89	77	192

	INPUT	* * * * * FINAL * * * * * *		
	BASE LEVEL	BASE LEVEL	DEPOT LEVEL	TOTAL FOR CAUSE
REM/1000EFH	0.0822	4.5588	0.1471	4.7059
NRTS PERCENT	85.00	100.00		
% DEP REPAIR			100.00	100.00

Table 6.

MODULE REMOVALS SUMMARY PAGE 12

DATE 061879 TIME 11:46 SEC 24

M	MODULE NOMENCLATURE	* * * PRIMARY * * * * USE	U-DEP	TIME	SCREEN	TOTAL	CONSTANT INTERVAL
1	700 AUGMENTOR	50	0	0	0	50	100
2	100 ACC1 WLL	0	0	88	72	160	100
3	300 FAN	8	0	70	55	133	100
4	400 CORE	4	0	111	77	192	100
5	500 H P TURB	4	0	97	20	121	100
6	600 FAN DR TUR	6	0	43	21	70	100
7	800 GEARBOX	1	0	10	22	33	100
8	900 ACC2 WOLL	138	0	0	0	138	100
GRAND TOTAL		211	0	419	257	897	

PARTS REMOVAL SUMMARY PAGE 14

>>> 400 CORE

Table 7.

PART NO. J	PART NAME	* * * * * * * * REMOVALS * * * * * * * USAGE	TOLERANCE	U-DEP	TIME	SCREEN	TOTAL	CONSTANT SCREEN
16	400 CORE DUMMY	4	0	0	0	0	4	100
17	401 4STG SEAL	0	0	0	4	6	10	100
18	402 5STG SEAL	0	0	0	3	3	6	100
19	403 6STG SEAL	0	0	0	6	5	11	100
20	404 7STG SEAL	0	0	0	4	5	9	100
21	405 8STG SEAL	0	0	0	11	5	16	100
22	406 9STG SEAL	0	0	0	9	7	16	100
23	407 10STG SEAL	0	0	0	7	9	16	100
24	408 11STG SEAL	0	0	0	7	9	16	100
25	409 12STG SEAL	0	0	0	10	6	16	100
26	410 13STG SEAL	0	0	0	2	4	6	100
27	411 4STG DISK	0	0	0	2	4	6	100
28	412 5STG DISK	0	0	0	5	2	7	100
29	413 6STG DISK	0	0	0	2	2	4	100
30	414 7STG DISK	0	0	0	5	12	17	100
31	415 8STG DISK	0	0	0	6	6	12	100
32	416 9STG DISK	0	0	0	3	8	11	100
33	417 10STG DISK	0	0	0	3	3	6	100
34	418 11STG DISK	0	0	0	3	3	6	100
35	419 12STG DISK	0	0	0	4	5	9	100
36	420 13STG DISK	0	0	0	4	3	7	100
37	421 REAR SHAFT	0	0	0	3	3	6	100
MODULE TOTALS		4	0	0	103	110	217	

Table 8.

OBJECTIVE FUNCTION PAGE 16

COMPLETE ENGINE MAINTENANCE COSTS

* * * * FACTORS * * * *

	ENGINE REMVLS	* 15/ 200	REM/REP CST/REM	AV.BASE CST/REM	AV.DEP. CST/REM	15-YEAR COSTS
BASE REMVLS	513	38.4750	164			6118
BASE RTS	507	38.0250		1805		68668
DEPOT NRTS	6	0.4500			15801	7110
GRAND TOTAL						81896

OBJECTIVE FUNCTION

MODULE MAINTENANCE COST WITH

ITEM	MODULE NOMENCLATURE	TOTAL NRTS MOD REMOVLS	*15/ 200	DEPOT COST FACTOR	TOTAL 15 YRS DEPOT
1	700 AUGMENTOR	0	0.	1753	0
2	100 ACC1 WLL	5	0.3750	846	317
3	300 FAN	5	0.3750	3200	1200
4	400 CORE	6	0.4500	6025	2711
5	500 H P TURB	3	0.2250	1507	339
6	600 FAN DR TUR	4	0.3000	3020	906
7	800 GEARBOX	2	0.1500	1066	159
8	900 ACC2 WOLL	1	0.0750	124	9
				TOTAL	5641

OBJECTIVE FUNCTION

Table 9.

COMPLETE ENGINE PIPELINE COSTS

DAILY REM/1000FH	DEMAND RATE *17/30000	N R RATE	T S PIPE	B A RATE	S F PIPE	PIPELINE QUANTITY	STK LIST PRICE	TOTAL COST
1.5735	0.0071250	1.2	42	98.8	0	0.03167	1700000	53833

Table 10.

MODULE MAINTENANCE COSTS-ALONE

ITEM	TOTAL NRTS MOD REMVLS	*15/ 200	DEPOT COST FACT	TOTAL BASE MOD REMVLS	*15/ 200	BASE COST FACT	TOTAL 15 YRS DEPOT&BASE
1	2	0.1500	1753	48	3.6000	775	3051
2	155	11.6250	846	0	0.	846	9834
3	125	9.3750	3200	3	0.2250	839	30188
4	186	13.9500	6025	0	0.	675	84048
5	117	8.7750	1507	1	0.0750	850	13286
6	64	4.8000	3020	2	0.1500	536	14576
7	31	2.3250	1066	0	0.	299	2478
8	0	0.	124	137	10.2750	0	0
						TOTAL	157461

Table 11.

MODULE PIPELINE COSTS

ITEM	DAILY DEMAND RATE REM/1000FH	*17/30000	NRTS PIPE	BASE PIPE	PIPELINE QTY/MOD	MODULE PRICE	COST PER MODULE
1	1.2255	0.0006944	22	4	0.00328	360000	1180
2	3.7990	0.0021528	4	2	0.00861	67426	580
3	3.1373	0.0017778	23	4	0.04030	177000	7097
4	4.5588	0.0025833	36	8	0.09300	704000	65471
5	2.8922	0.0016389	29	3	0.04737	131028	6180
6	1.6176	0.0009167	19	5	0.01703	169000	2877
7	0.7598	0.0004306	16	2	0.00659	23000	158
8	3.3578	0.0019028	0	1	0.00190	0	0
						TOTAL	83563

Table 11 (a).

TRANSPORTATION COSTS

ITEM	NOMENCLATURE	NRTS REMOVALS	* 15/ 200	TRANSPT CST/REM	15-YEAR COSTS
ENG	COMPLETE ENG.	6	0.4500	5000	2250
1	700 AUGMENTOR	2	0.1500	2066	309
2	100 ACC1 WLL	155	11.6250	0	0
3	300 FAN	125	9.3750	888	8325
4	400 CORE	186	13.9500	2013	28081
5	500 H P TURB	117	8.7750	423	3711
6	600 FAN DR TUR	64	4.8000	1107	5313
7	800 GEARBOX	31	2.3250	200	464
8	900 ACC2 WOLL	0	0.	0	0

MODULES TOTAL 46203

GRAND TOTAL 48453

Table 12.

LIFE-LIMITED PARTS REPLACEMENT COSTS
FOR 15-YEAR LIFE CYCLE

>>> 400 CORE

	PART NO.	PART NAME	TOTAL SCHED RMVL(200YR)	SCHED RMVL (15YR)	UNIT PRICE	TOTAL 15-YR
16	400	CORE DUMMY	0	0.	5500	0
17	401	4STG SEAL	10	0.75000	1093	819
18	402	5STG SEAL	6	0.45000	1280	576
19	403	6STG SEAL	11	0.82500	1424	1174
20	404	7STG SEAL	9	0.67500	1163	785
2[illegible]	405	8STG SEAL	16	1.20000	1742	2090
	406	9STG SEAL	16	1.20000	1118	1341
23	407	10STG SEAL	16	1.20000	3292	3950
24	408	11STG SEAL	16	1.20000	3308	3969
25	409	12STG SEAL	16	1.20000	3369	4042
26	410	13STG SEAL	6	0.45000	5283	2377
27	411	4STG DISK	6	0.45000	4708	2118
28	412	5STG DISK	7	0.52500	3893	2043
29	413	6STG DISK	4	0.30000	8134	2440
30	414	7STG DISK	17	1.27500	6764	8624
31	415	8STG DISK	12	0.90000	4448	4003
32	416	9STG DISK	11	0.82500	8549	7052
33	417	10STG DISK	6	0.45000	4441	1998
34	418	11STG DISK	6	0.45000	8448	3801
35	419	12STG DISK	9	0.67500	4641	3132
36	420	13STG DISK	7	0.52500	8486	4455
37	421	REAR SHAFT	6	0.45000	9793	4406
				MODULE SUBTOTAL		55195

Table 13.

OBJECTIVE FUNCTION SUMMARY　　　PAGE 21

F100PW100(F15)

DATE 061879　　　TIME 11.46 SEC 24

ITEM	* * * MAINTENANCE COSTS * * * ALONE BASE	ALONE DEPOT	WITH DEPOT	TOTALS	PIPE LINE COSTS	TRANS PORT COSTS	PARTS COSTS	15-YEAR COSTS
ENG	74786		7110	81896	53833	2250		137979
1	2789	262	0	3051	1180	309	0	4540
2	0	9834	317	10151	580	0	86271	97002
3	188	30000	1200	31388	7097	8325	43131	89941
4	0	84048	2711	86759	65471	28081	65195	245506
5	63	13223	339	13625	6180	3711	75635	99151
6	80	14496	906	15482	2877	5313	41013	64685
7	0	2478	159	2637	158	464	1641	4900
8	0	0	9	9	0	0	0	9
MODTOT	3120	134341	5641	163102	83543	46203	312886	605734
GRAND TOTALS				244998	137376	48453	312886	743713

Table 14.

* SCREEN, NRTS RATE & REMOVALS PER 1000 FH *
SUMMARY

DATE 061879 TIME 11.46 SEC 24

ITEM NAME	CONSTANT SCREEN INTERVAL	* I N I T I A L * NRTS RATE %	REM/ 1000 FH.	* * F I N A L * * NRTS RATE %	REM/ 1000 FH.
C ›LETE ENG.		4.70	4.7000	1.17	12.5735
700 AUGMENTOR	100	9.00	1.0904	4.00	1.2255
100 ACC1 WLL	100	0.	0.	100.00	3.7990
300 FAN	100	86.00	0.2632	97.66	3.1373
400 CORE	100	85.00	0.0822	100.00	4.5588
500 H P TURB	100	70.00	0.0588	99.15	2.8922
600 FAN DR TUR	100	53.00	0.1692	96.97	1.6176
800 GEARBOX	100	77.00	0.1786	100.00	0.7598
900 ACC2 WOLL	100	0.	3.1443	0.	3.3578

RULE OF X WAS 4

Table 15.

```
>>>> * AVERAGE DATA * <<<<

ENGINE REMOVALS          PAGE    1

REPORT PERIOD SUMMARY

F100PW100 (F15)
---------------

SEED RUN 2                                          INPUT    OUTPUT
                                       REM/1000FH   4.7000   12.3039
SIMULATION PERIOD IS  40800            NRTS %       4.70      1.09
REPORT PERIOD IS          4080
LIFE PERIOD FOR OBJECTIVE FUNCTION IS     15 YEARS
MONTHLY UTILIZATION RATE IS     17 FLYING HOURS
WARMUP   YES
SEED IS RANDOM
NUMBER OF MODULES  8          RULE OF X WAS  4
```

ENGINE REMOVALS

REPORT PERIOD K	HOURS	* * USAGE ONE MOD. FAILS EARLY	* * * MANY MODS. EARLY	... TIME MANY MODS. U+T	... ONE NOT REACHED	TOTAL
1	4080	7	0	32	14	53
2	8160	10	1	27	20	58
3	12240	8	1	27	12	48
4	16320	6	1	29	13	49
5	20400	7	0	29	14	50
6	24480	9	0	28	12	49
7	28560	9	0	28	13	50
8	32640	10	0	25	17	52
9	36720	7	1	28	12	48
10	40800	6	0	30	18	54
TOTALS		79	4	283	145	511

SEED TOTAL   1004

Table 15. (cont.)

>>>> * AVERAGE DATA * <<<<

OBJECTIVE FUNCTION SUMMARY PAGE 3

F100PW100(F15)

DATE 061879 TIME 11.46 SEC 46

ITEM	* * * MAINTENANCE COSTS * * * ALONE BASE	ALONE DEPOT	WITH DEPOT	TOTALS	PIPE LINE COSTS	TRANS PORT COSTS	PARTS COSTS	15-YEAR COSTS
ENG	72682		6518	79200	52346	2063		133609
1	2528	328	0	2856	1145	387	0	4388
2	0	11167	317	11484	659	0	85892	98035
3	251	30120	960	31331	7135	8358	43358	90182
4	0	83596	2485	86081	65120	27930	65002	244133
5	95	10680	283	11058	4995	2998	75632	94683
6	80	14722	906	15708	2922	5396	41013	65039
7	0	2558	119	2677	163	480	1667	4987
8	0	0	5	5	0	0	0	5
MODTOT	2954	153171	5075	161200	82139	45549	312564	601482
GRAND TOTALS				240400	134485	47612	312564	735061

S_ D TOTALS 480794 268966 95220 625125 1470105

>>>> * AVERAGE DATA * <<<<

* SCREEN, NRTS RATE & REMOVALS PER 1000 FH *
SUMMARY

DATE 061879 TIME 11.46 SEC 46

ITEM NAME	CONSTANT SCREEN INTERVAL	* I N I T I A L * NRTS RATE %	REM/ 1000 FH.	>>> * AVERAGE * <<< * * F I N A L * * NRTS RATE %	REM/ 1000 FH.
COMPLETE ENG.		4.70	4.7000	1.09	12.3039
700 AUGMENTOR	100	9.00	1.0904	5.57	1.1275
100 ACC1 WLL	100	0.	0.	100.00	4.3137
300 FAN	100	56.00	0.2632	96.92	3.1740
400 CORE	100	85.00	0.0822	100.00	4.5343
500 H P TURB	100	70.00	0.0588	98.22	2.3529
600 FAN DR TUR	100	53.00	0.1692	97.01	1.6422
800 GEARBOX	100	77.00	0.1786	100.00	0.7843
900 ACC2 WOLL	100	0.	3.1443	0.	3.2475

R[illegible] OF X WAS 4

SEED TOTALS NRTS % 2.19 REMOVALS 24.6078

Table 15. (cont.)

>>>> * AVERAGE DATA * <<<<

MODULE REMOVALS SUMMARY PAGE 2

DATE 061879 TIME 11.46 SEC 46

M	MODULE NOMENCLATURE	* * * PRIMARY USE	U-DEP	TIME	SCREEN * * * *	TOTAL	CONSTANT INTERVAL
1	700 AUGMENTOR	46	0	0	0	46	100
2	100 ACC1 WLL	0	0	89	93	182	100
3	300 FAN	10	0	67	58	135	100
4	400 CORE	4	0	111	76	191	100
5	500 H P TURB	4	0	79	17	100	100
6	600 FAN DR TUR	7	0	40	25	72	100
7	800 GEARBOX	1	0	9	24	34	100
8	900 ACC2 WOLL	133	0	0	0	133	100
	GRAND TOTAL	205	0	395	293	893	
	SEED TOTALS	407	0	786	581	1774	

Table 16.

DATA1 ACTUARIAL INPUT FACTORS

ENGINE F100PW100(F15)

DEPOT PIPE IS 42 BASE PIPE IS 4 LIST PRICE IS 1700000
DEPOT MAINT COST IS 15801 BASE MAINT COST IS 161

700 AUGMENTOR

DEPOT PIPE IS 22 BASE PIPE IS 4 LIST PRICE IS 360000
DEPOT MAINT COST IS 1753 BASE MAINT COST IS 775
TRANSPORT COST 2066 MANHOUR DATA 30

PART NO.	PART NAME	CONVERT RATIO	MAX. TIME	SHAPE PARAM	SCALE PARAM	UNIT PRICE
1	700 AUGM DUMMY	1.000	000000	2.00	974	0

100 ACC1 WLL

DEPOT PIPE IS 4 BASE PIPE IS 2 LIST PRICE IS 67426
DEPOT MAINT COST IS 846 BASE MAINT COST IS 846
TRANSPORT COST 0 MANHOUR DATA 23

PART NO.	PART NAME	CONVERT RATIO	MAX. TIME	SHAPE PARAM	SCALE PARAM	UNIT PRICE
2	100 ACC1 DUMMY	1.000	000000	2.00	990000	20000
3	110 FNT FN DCT	1.600	1250	5.00	990000	6209
4	111 R FN DCT	1.600	1250	5.00	990000	9053
5	301 VANE	1.600	1000	5.00	990000	3890
6	302 VANE	1.600	1200	5.00	990000	828

300 FAN

DEPOT PIPE IS 23 BASE PIPE IS 4 LIST PRICE IS 177000
DEPOT MAINT COST IS 3200 BASE MAINT COST IS 839
TRANSPORT COST 888 MANHOUR DATA 78

PART NO.	PART NAME	CONVERT RATIO	MAX. TIME	SHAPE PARAM	SCALE PARAM	UNIT PRICE
7	300 FAN DUMMY	1.000	000000	2.00	4033	2500
8	303 1STG DISK	2.200	3400	5.00	990000	7310
9	304 2STG DISK	2.200	3300	5.00	990000	6054
10	305 3STG DISK	2.200	3000	5.00	990000	5016
11	306 1STG SEAL	2.200	10000	5.00	990000	1848
12	307 FRNT SEAL	2.200	10000	5.00	990000	1106
13	308 REAR SEAL	2.200	10000	5.00	990000	1347
[illegible]	309 RETAINER	2.200	10000	5.00	990000	744
[illegible]	310 2STG SEAL	2.200	10000	5.00	990000	2045

Table 16. (cont.)

400 CORE

DEPOT PIPE IS 36 BASE PIPE IS 8 LIST PRICE IS 704000
DEPOT MAINT COST IS 6025 BASE MAINT COST IS 675
TRANSPORT COST 2013 MANHOUR DATA 213

PART NO.	PART NAME	CONVERT RATIO	MAX. TIME	SHAPE PARAM	SCALE PARAM	UNIT PRICE
16	400 CORE DUMMY	1.000	000000	2.00	12915	5500
17	401 4STG SEAL	2.200	9400	5.00	990000	1093
18	402 5STG SEAL	2.200	17500	5.00	990000	1280
19	403 6STG SEAL	2.200	8200	5.00	990000	1424
20	404 7STG SEAL	2.200	11000	5.00	990000	1163
21	405 8STG SEAL	2.200	5600	5.00	990000	1742
22	406 9STG SEAL	2.200	5500	5.00	990000	1118
23	407 10STG SEAL	2.200	5600	5.00	990000	3292
24	408 11STG SEAL	2.200	5600	5.00	990000	3308
25	409 12STG SEAL	2.200	5600	5.00	990000	3369
26	410 13STG SEAL	2.200	15000	5.00	990000	5283
27	411 4STG DISK	2.200	15000	5.00	990000	4708
28	412 5STG DISK	2.200	13000	5.00	990000	3893
29	413 6STG DISK	2.200	21000	5.00	990000	8134
30	414 7STG DISK	2.200	5500	5.00	990000	6764
31	415 8STG DISK	2.200	7500	5.00	990000	4448
32	416 9STG DISK	2.200	8300	5.00	990000	8549
33	417 10STG DISK	2.200	15500	5.00	990000	4441
34	418 11STG DISK	2.200	14000	5.00	990000	8448
35	419 12STG DISK	2.200	10500	5.00	990000	4641
36	420 13STG DISK	2.200	13500	5.00	990000	8486
37	421 REAR SHAFT	2.200	15500	5.00	990000	9793

500 H P TURB

DEPOT PIPE IS 29 BASE PIPE IS 3 LIST PRICE IS 131028
DEPOT MAINT COST IS 1507 BASE MAINT COST IS 850
TRANSPORT COST 423 MANHOUR DATA 158

PART NO.	PART NAME	CONVERT RATIO	MAX. TIME	SHAPE PARAM	SCALE PARAM	UNIT PRICE
38	500 HPT DUMMY	1.000	000000	2.00	18054	5500
39	501 1STG DISK	2.200	8100	5.00	990000	14553
40	502 2STG DISK	2.200	9800	5.00	990000	12416
41	503 2STG DISK	2.200	1800	5.00	990000	10475
42	504 1STG FPLT	2.200	1800	5.00	990000	4077
43	505 1STG RPLT	2.200	1800	5.00	990000	98

Table 16. (cont.)

600 FAN OR TUR

DEPOT PIPE IS 19 BASE PIPE IS 5 LIST PRICE IS 169000
DEPOT MAINT COST IS 3020 BASE MAINT COST IS 536
TRANSPORT COST 1107 MANHOUR DATA 113

PART NO.	PART NAME	CONVERT RATIO	MAX. TIME	SHAPE PARAM	SCALE PARAM	UNIT PRICE
44	600 FDT DUMMY	1.000	000000	2.00	6274	1716
45	601 3STG DISK	2.200	3300	5.00	990000	8024
46	602 4STG DISK	2.200	3000	5.00	990000	6502
47	603 4STG DISK	2.200	10000	5.00	990000	15017

800 GEARBOX

DEPOT PIPE IS 16 BASE PIPE IS 2 LIST PRICE IS 23000
DEPOT MAINT COST IS 1066 BASE MAINT COST IS 299

TRANSPORT COST 200 MANHOUR DATA 13

PART NO.	PART NAME	CONVERT RATIO	MAX. TIME	SHAPE PARAM	SCALE PARAM	UNIT PRICE
48	800 GBOX DUMMY	1.600	2000	2.00	5944	684

900 ACC2 WOLL

DEPOT PIPE IS 0 BASE PIPE IS 1 LIST PRICE IS 0
DEPOT MAINT COST IS 124 BASE MAINT COST IS 0
TRANSPORT COST 0 MANHOUR DATA 16

PART NO.	PART NAME	CONVERT RATIO	MAX. TIME	SHAPE PARAM	SCALE PARAM	UNIT PRICE
49	900 ACCS DUMMY	1.000	000000	2.00	338	0

VI. Program LAU/OMENS2.S,R

1. This program is written in FORTRAN for use on the CREATE system in AFLC. The CREATE system is a time-sharing/batch computer system which uses the H635 computer. This program can be run in the background as a batch run. It is stored in file LAU, under the name OMENS2.S, and can be called after the user is logged on under the CARD system by typing OLD LAU/ OMENS2.S,R.

2. Purpose of Program: This model simulates the operation of a single typical engine, F100PW100, installed in an F-15 aircraft. Each engine has m modules and each module has j parts, one per module may be a dummy part which is included so that module removals not caused by one of the other j-1 parts can be accounted for. The engine removals are driven by removals required on the m modules (one of which is the engine "dummy," i.e., Accessories - 2). The module removals are driven by the part removals required on the j parts. Premature removal rate factors, initial NRTS rates, and life limits are needed as input for the model. The model produces long run (based on input life cycle time removals), classified into usage, time, and screened out reasons for removal. Report periods are variable, also stated at input time. The

model is used in (1) simulation studies whose objectives are to identify preferred opportunistic replacement policies for each module, (2) to calculate composite removals per 1000FH and corresponding aggregate NRTS rates, (3) to calculate an objective function yielding maintenance, pipeline, transportation, and parts costs for a chosen life cycle period.

3. The Dimensions and Declarations are presented at the very beginning of the program and continue through Line 400. Comment statements are used to set off different segments of the program, as shown in Line 80.

```
CATALOG/FILE DESCRIPTION=  LAU/OMENS2.S

10##NORM
20$:LIMITS:4,40K,,5K
30$:IDENT:WP1271,XRSL/JINYA    OMENS2.S
40$:OPTION:FORTRAN
50$:FORTY:DECK,NLNO,NFORM
60$:PRMFL:C*,W,S,LAU/OMENS2.O
70C
80C DIMENSIONS AND DECLARATIONS
90C
100    CHARACTER ENGINE*14,MODULE*14,PART*14,WARMUP*3,SOTYP*8,XDATE*6
110    CHARACTER INDATA*5,KRSCRN*8,KONPER*8,BLKAVG*19
120    PARAMETER MM=8,JJ=49,KK=10,NN=MM+1
130    DIMENSION MODULE(MM),PART(JJ)
140    DIMENSION MSCRN(MM),BNRTSPC(MM),BRKFH(MM),FNRTSPC(MM),KPV(MM)
150    DIMENSION FRKFH(MM),R(JJ),SHP(JJ),ALOC(JJ),SCL(JJ),JPMOT(JJ)
160    DIMENSION NGUSE1(KK),NGUSE2(KK),NGTM2(KK),NGTM1(KK)
170    DIMENSION NGTOTR(KK),MRTS(MM),MUNRTS(MM),LCMCST1(MM),LCMCST2(MM)
180    DIMENSION MUSNRTS(MM),MSCHNRTS(MM),MSCRNRTS(MM),MTNRTS(MM)
```

```
190   DIMENSION MXUNRTS(MM),MXUSNRTS(MM),MXSCHNRT(MM),MXSCHNRT(MM)
200   DIMENSION MXOKNRTS(MM),MODUSE1(MM,KK),MODUSE2(MM,KK)
210   DIMENSION MODTM2(MM,KK),MODTM1(MM,KK),MODTOTR(MM,KK)
220   DIMENSION MODSCR(MM,KK),MTUSE1(MM),MTUSE2(MM),MTTM2(MM)
230   DIMENSION MTTM1(MM),MTTOTR(MM),MTSCR(MM),MUSE(MM),[illegible](MM)
240   DIMENSION MTM(MM),MSCR(MM),MTOTR(MM),MOT(JJ),LCMCST3(MM)
250   DIMENSION JSCL(JJ),JUSE(JJ),JTM(JJ),JSCR(JJ),JTOTR(JJ)
260   DIMENSION JPART(JJ),MOD(MM),JF(NN),JTOLR(JJ),[illegible](JJ)
270   DIMENSION MOBFNCST(MM),MJUSET(MM),MJTOLRT(MM),MJUDPPT(MM)
280   DIMENSION MJTMT(MM),MJSCRT(MM),MJTOTRT(MM),JMSCR(JJ,KK)
290   DIMENSION JTPSCHD(JJ),JTLCPCST(JJ),MGTLCPCS(MM)
300   DIMENSION MDPIPE(MM),MBPIPE(MM),MPIPCST(MM),FACNRDSW(MM)
310   DIMENSION MDPCST(MM),MBSCST(MM),LCMCST(MM),RLCPSCHD(JJ)
320   DIMENSION DLCMDDR(MM),PIPEQTYM(MM),FACMNRTS(MM),FACMRTS(MM)
330   DIMENSION JTTF(JJ),JTTL(JJ),MSLP(MM),JSLP(JJ),[illegible](MM)
340   DIMENSION FRKFHD(MM),FRKFHC(MM),DEPPC(MM),[illegible](MM),LCST[illegible](MM)
350   DIMENSION MAUSE(MM),MAUD(MM),MATM(MM),MASCR(MM),LXCST[illegible](MM)
360   DIMENSION MXGPCS(MM),MXPIP(MM),LXCST4(MM),LXCST3(MM),LXCS[illegible](MM)
370   DIMENSION NGU1(KK),NGU2(KK),NGT1(KK),NGT2(KK),FNRTS(MM),[illegible](MM)
380   DIMENSION MTRCST(MM),MBSEPMH(MM),LCMTRANS(MM),MX[illegible](MM),LXCST2(MM)
390C
400C
```

4. <u>The Main Routine</u> is in Lines 410 through 1930. The routine starts out setting the date and time in hours, minutes, and seconds. Following this, initialization, warmup options, and table headings are carried out. The main computations are done in the many GO TO statements shown below.

```
410C * * * * M A I N * * * * * * * *
420C
430C SET DATE AND TIME
440 GOTO 1000
450C
460C  READ INPUT DATA
470C
480 1500 GOTO 9000
490C
500C INITIALIZE ALL ACCUMULATORS
510C
520 8900 GOTO 750
522C
523C
524C
525 2 GO TO 900
526C
```

```
C
6 GO TO 1100
C
C
C INITIALIZE JTTF(J) AND JTTL(J) FOR ALL J PARTS
C
200 GO TO 2100
C
C WARMUP DESIRED
C
240 IF(KW.NE.1) GO TO 1
C
C WARMUP
C
250 GO TO 4100
C
C SCALE REPORT PERIOD COUNTERS
C INTERVAL WIDTH = INPUT REPORT PERIOD
C
199 KLAST = (FLOAT(ISIMPRD)/FLOAT(IRPTPRD))+.9
IF(KLAST.LE.KK)  GO TO 200
 PRINT 1483
1483  FORMAT(" ","PARAMETER KK IN LINES 1030 AND 1480 TOO SMALL")
 STOP
C
C FOR EACH REPORT PERIOD, K
C
C * * * * * * * * * * * * * * * * * * * * * * * * * * * *
1 DO 100 K = 1,KLAST
C * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
C FIND MIN TIME TIL FAILURE AND MIN TIME TIL LIMIT
C
5 GOTO 4200
C
C COUNT MULTIPLE PARTS REMOVALS
C
10 GO TO 4300
C
C REMOVALS THIS REPORT PERIOD
C
20 IF(MINF.LT.K3) GO TO 40
   IF(MINL.LT.K3) GO TO 40
C
C NO REMOVALS THIS REPORT PERIOD
C
C UPDATE ALL PARTS FOR REMAINING TIME IN THIS K PERIOD
 GO TO 4400
C
C
35 GO TO 100
```

```
C CODE REASONS FOR REMOVAL FOR PARTS, MODULES, AND
C FOR ENGINE, AND APPLY SCREENS AND TOLERANCE INTERVALS
C AND REPLACE REMOVED PARTS
C
 40 GO TO 4600
C
C RECORD ALL PARTS, MODULES, ENGINE REMOVALS
C ENGINE REMOVALS BY REPORT PERIOD, K
C
 50 GO TO 5100
C
C MODULE REMOVALS FOR ENGINE NRTS ANALYSIS REPORTS
C
 60 GO TO 5105
C
C MODULE REMOVALS BY REPORT PERIOD, K
C
 70 GO TO 5135
C
C MODULE REMOVAL SUMMARY BY CAUSE
C
 80 GO TO 5145
C
C PART REMOVALS BY CAUSE
C
 90 GO TO 5155
C
C REPLACE REMOVED PARTS
C
 95 GO TO 5200
C
C FIND TIME TO NEXT REMOVAL OF ENGINE, MODULES, PARTS
C
 97 GO TO 5
C NEXT K PERIOD
C
C * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
 100 CONTINUE
C * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
C PRE-OUTPUT - REMOVAL TABLES
C
 GO TO 5300
C
C OUTPUT -- REMOVAL TABLES
C
 105 GO TO 5600
C
```

```
C PRE-OUTPUT -- OBJECTIVE FUNCTION
C
 106 GO TO 7300
C
C OUTPUT -- OBJECTIVE FUNCTION
C
 107 GO TO 7400
C
C OUTPUT -- SCREEN, NRTS, REM/1000FH SUMMARY AND ACTUARIAL INPUT
C
  108 GO TO 8200
C
C AVERAGE DATA OR PRINT ACTUARIAL DATA (9997)
C
C
 9992 IF(ISMAX.EQ.1) GO TO 9997
  GO TO 8600
C
C  AVERAGES PRINT ROUTINES
C
 9993 IAVG=IAVG+1
  PRINT 9994
 9994 FORMAT("1",T25,">>>> * AVERAGE DATA"," * <<<<")
C
  IF(IAVG.EQ.1) GO TO 1030
  IF(IAVG.EQ.2) GO TO 6400
  IF(IAVG.EQ.3) GO TO 8100
  GO TO 9999
C
C  HALF PAGE AVERAGES
C
 9995 PRINT 9996
C
 9996 FORMAT("0",T25,">>>> * AVERAGE DATA"," * <<<<")
C
  GO TO 8200
C
C  PRINT INPUT DATA
C
 9997 GO TO 8300
C
C
C END OF COMPUTATION
C
 9998 GO TO 9999
C
C * * * * END OF MAIN * * * * *
C
```

5. The rest of the program consists mainly of a number of subsections and initialization logic. The following paragraphs will provide additional comments about each of these sections.

6. Initialize Average Accumulators/Set Date and Time. This section of the program initializes the average accumulators for the averages tables. The date and time are also set in this section. The monthly utilization factor is also computed.

```
C INITIALIZE AVERAGES ACCUMULATORS
C
 1000 IAVG=0
  BLKAVG="                    "
C
  ISDRUN = 0
 1020 ISDRUN = ISDRUN + 1
C SET DATE AND TIME
C
  CALL ADATE(XDATE)
 1030 CALL TIME(ITIME)
  FTIME = FLOAT(ITIME)/10**7
  HTIME = FLOAT(ITIME)/10**5
  KTIME = IFIX(HTIME)*100
  STIME = FLOAT(ITIME)/10**3
  JTIME = IFIX(STIME)
  LTIME = JTIME-KTIME
  IF(LTIME.GT.49) FTIME = FTIME-.01
C
 1040 IPG = 0
C
 1050 IF(IAVG.EQ.1) GO TO 5700
C
  IF (ISDRUN.GT.1) GO TO 6
C
C
C
  GOTO 1500
C
C
C COMPUTE MONTHLY UTILIZATION FACTOR
C
 750 DCONVR = 1000.D*30.0
  IDCR = IFIX(DCONVR)
C
```

7. <u>Subsection 2260-3690, Initialize and Define Run Variables.</u>

This section of the program defines the run variables, initializes accumulators, and reads the user input data.

```
2260C - - SCREEN POLICIES - -
2270C
2280  DATA(MSCRN(I),I=1,8)/8*450/
2290  DATA(KPV(I),I=1,8)/8*0/
2300  DATA(JPMOT(I),I=1,49)/49*0/
2301C
2302C RUN VARIABLES DEFINED
2310C
2320C ISIMYRS=TOTAL NUMBER OF SIMULATION YEARS
2330C ISIMPRD=NUMBER OF SIMULATION YEARS IN SIMULATION PERIOD
2340C MONUTR=MONTHLY UTILIZATION RATE; IRPTPRD=NUMBER YRS IN REPORT PERIOD
2350C ISDRUN=NUMBER OF SEED RUNS;   COUNTS UP TO ISMAX
2360C ISMAX=TOTAL NUMBER OF SEED RUNDS DONE
2370C LFCYC=LIFE CYCLE; JTOL=TOLERANCE VALUE
2380C SDTYP=SEED TYPE; MRULE=RULE OF X VALUE
2390C KPI=CONSTANT SCREEN IF 0; PERCENT MOT SCREEN IF 1
2400C IP=PRINT INDICATOR,LONG RUN=0,SHORT RUN=1
2401C
2410C - - RUN VARIABLES - - - - - - - - - - - - - - - - - - - - -
2420C
2430  ISIMYRS = 200; MONUTR = 17 ; ISDRUN = 1  ; KPI = 0 ;IAVG=0
2440  ISIMPRD = 0 ;  LFCYC = 15 ;  JTOL = 10  ;  ISMAX = 1
2450  SDTYP = "FIXED";  MRULE = 4 ;  IRPTPRD = 0  ;  IP = 0
2460C SET KW = 0 IF NO WARMUP IS DESIRED, OR 1 IF WARMUP
2470  KW = 1
2480C  SET KS = 0 IF STANDARD SEED IS DESIRED, OR 1 IF RANDOM
2490  KS = 1
2500C
2510  READ 32,MRULE,KPI,(KPV(I),I=1,8),ISMAX,IP,KS,KW,LFCYC,ISIMYRS,MONUTR
2520 32 FORMAT(I1,1X,I1,8(1X,I3),1X,I1,1X,I1,1X,I1,1X,I1,1X,I2,1X,I3,1X,I2)
2530C
2540 PRINT 34,MRULE,KPI,(KPV(I),I=1,8),ISMAX,IP,KS,KW,LFCYC,ISIMYRS,MONUTR
2550 34 FORMAT("0","VALUES INPUT ",I1,1X,I1,8(1X,I3),1X,I1,1X,I1,1X,
2560&I1,1X,I1,1X,I2,1X,I3,1X,I2)
2570C
2580  WARMUP = "NO" ; SEED = 19.0 ; KPSCRN = "CONSTANT"
2590   KONPER = "CONSTANT"
2600  IF(KPI.EQ.1) KPSCRN = "% OF MOT"
2610  IF(KPI.EQ.1) KONPER = "PERCENT "
2620  IF(KW.EQ.1) WARMUP = "YES"
2630  IF(KS.EQ.1) SEED = FTIME
2640  IF(KS.EQ.1) SDTYP = "RANDOM"
2650  ISIMPRD = ISIMYRS*MONUTR*12
2660  IRPTPRD = ISIMPRD/KK
```

```
C
      IF(ISMAX.EQ.0) GO TO 870
C
  800 IF(KPI.EQ.0) GO TO 850
      KNT = 0
      DO 810 M=1,MM
      IF(KPV(M).GT.100)  KNT=KNT+1
      IF(KPV(M).LT.0) KNT = KNT+1
  810 CONTINUE
      IF(KNT.GT.0)  GO TO 880
C
  820 PMOT = 0
      DO 840 M = 1,MM
      DO 830 J = JF(M),(JF(M+1)-1)
      PMOT = FLOAT(KPV(M))/100.0*FLOAT(MOT(J))
      JPMOT (J) = IFIX(PMOT)
  830 CONTINUE
      MSCRN (M) = IFIX(PMOT)
  840 CONTINUE
      GO TO 2
C
  850 DO 860 M=1,8
      MSCRN (M) = KPV (M)
  860 CONTINUE
      GO TO 2
  870 PRINT 872
  872 FORMAT("0","ISMAX IN ERROR ")
      GO TO 9999
  880 PRINT 885,KNT
  885 FORMAT("0",I4,2X,"PERCENT VALUES EXCEED 100 OR NEGATIVE")
      GO TO 9999
C
C INITIALIZE ACCUMULATORS
C
```

```
900 IAOBGZOT=0;NXTRAN=0;MAUSET=0;MAUDT=0;MATMT=0;MASCRT=0
  IXCST=0;IXPIP=0;IXPART=0;NXBIP=0;NXBCST=0;MXBIPT=0;LXCMST=0
  LXCMST3=0;LXCMST4=0;LXECST=0;IXBFNT=0;NXBFN=0;MXTRAN=0;NXREPO=0
  FNRTSPCT=0;ERKFHT=0;EAFH=0;EANRTS=0;IOBFNAX=0;MXTOT=0;NXBASE=0
  DO 950 M=1,MM
   MAUSE(M)=0;MAUD(M)=0;MATM(M)=0;MASCR(M)=0;LXCST1(M)=0
  MXGPCS(M)=0;MXPIP(M)=0;LXCST4(M)=0;LXCST3(M)=0;LXCST(M)=0
  FNRTS(M)=0;FKFH(M)=0;LXCST2(M)=0;MXTRCST(M)=0
950 CONTINUE
C
C
  DO 975 K=1,KK
  NGU1(K)=0;NGU2(K)=0;NGT1(K)=0;NGT2(K)=0
975 CONTINUE
C
  GO TO 6
C
C SUBSECTION 1100
C
C INITIALIZE TABLES AND ACCUMULATORS
C VARIABLES RELATED TO REPORT PERIODS, K
C
1100 DO 1115 K = 1,KK
  NGUSE1(K) = 0;NGUSE2(K)=0;NGTM2(K)=0;NGTM1(K)=0
  NGTOTR(K)=0
1115 CONTINUE
C
C VARIABLES RELATED TO BOTH MODULES,M,AND REPORT PERIODS,K
C
1120 DO 1150 M = 1,MM
1130 DO 1140 K = 1,KK
  MODUSE1(M,K)=0;MODTM2(M,K)=0;MODTM1(M,K)=0;MODTOTR(M,K)=0
  MODSCR(M,K)=0;MODUSE2(M,K)=0
1140 CONTINUE
1150 CONTINUE
C
C VARIABLES RELATED TO MODULES ALONE, M
C
```

```
 1160 DO 1170 M = 1,MM
      MRTS(M)=0;MUNRTS(M)=0;MUSNRTS(M)=0;MSCHNRTS(M)=0
      MSCRNRTS(M)=0;MXUNRTS(M)=0;MXUSNRTS(M)=0;MXSCHNRT(M)=0
      MXSCRNRT(M)=0;MXDRNRTS(M)=0;MUSE(M)=0;MUD(M)=0;MTM(M)=0
      MSCR(M)=0;MNRTSWTH(M)=0;LCMCST1(M)=0; LCMCST2(M)=0
      LCMCST3(M)=0;LCST4(M)=0;LCMTRANS(M)=0;LCMCST(M)=0
 1170 CONTINUE
C
C VARIABLES RELATED TO PARTS, J
C
 1180 DO 1190 J = 1,JJ
      JUSE(J)=0;JTM(J)=0;JSCR(J)=0;JTOLR(J)=0;JUDEP(J)=0
 1190 CONTINUE
C
C INITIALIZE TIME REMAINING THIS REPORT PERIOD
C
 ICLOCK = 0
      K3 = IRPTPRD
C
C UNSUBSCRIPTED ACCUMULATORS
C
      NENGTOT = 0; NENGNRTS=0; NBSEPTMH=0
C
C VARIABLES RELATED TO BOTH J AND K
C
      DO 1195 K = 1,KK
      DO 1196 J = 1,JJ
      JMSCR(J,K)=0
 1196 CONTINUE
 1195 CONTINUE
C
C RETURN
C
      GO TO 199
```

8. <u>Subsection 2100, Initialize Failure Times and Scheduled Removal Times</u>. This section of the program loads initial random flying hours till unscheduled removal (failure) for each part into JTTF(J) and reads each parts MOT, and converts it to equivalent flying hours by dividing it by the conversion factor R(J), given in input. This subsection is found in lines 3700 through 4010.

```
3700C
3710C SUBSECTION 2100
3720C
3730C INITIALIZE TIME TIL FAILURE,JTTF(J),AND TIME TIL LIFE
3740C LIMIT, JTTL(J), FOR EACH PART J
3750C
3760C LOAD RANDOM FLYING HOURS TIL UNSCHEDULED REMOVAL (FAILURE)
3770C FOR EACH PART INTO JTTF(J), AND READ EACH PART'S
3780C MAXIMUM OPERATING TIME, MOT(J), AND CONVERT TO EQUIVALENT
3790C FLYING HOURS BY DIVIDING BY CONVERSION FACTOR, R(J), GIVEN
3800C IN INPUT. SUBSECTION AT 4000 DOES THIS, AND IS USED
3810C THROUGHOUT THE PROGRAM WHENEVER A PART IS REPLACED
3820C
3830 2100 DO 2200 J = 1,JJ
3850  SCLE = FLOAT(JSCL(J))
3860  TTF=ALOC(J)+(SCLE-ALOC(J))*(-ALOG(UNIFM1(SEED)))**(1./SHP(J))
3870  JTTF(J) = IFIX(TTF)
3880  JTTL(J)=IFIX(FLOAT(MOT(J))/R(J))
3890 2200 CONTINUE
3900C
3960C RETURN
3970C
3980 2300 GOTO 240
4010C
```

9. <u>Subsection 4020, Load Next Removal Times.</u> This part of the program covers lines 4020 through 4390 and loads the removal times (both failure and scheduled) for each part that gets removed for maintenance or opportunistically during the program run.

```
4020C LOAD NEXT REMOVAL TIMES FOR PART J
4030C
4040C THIS SUBSECTION ASSUMES A WEIBULL DISTRIBUTION OF


4050C FAILURE.  EACH EXECUTION OF THIS SUBSECTION LOADS A TIME-
4060C TIL-FAILURE, JTTF(J), AND A TIME-TIL-LIFE-LIMIT, JTTL(J),
4070C FOR EACH PART J.  ALL TIMES ARE CONVERTED TO EQUIVALENT
4080C ENGINE FLYING HOURS.  ALL TIMES ASSUME THAT A ZERO AGE
4090C PART WAS INSTALLED.  JTTF(J) IS THE FLYING HOUR TIME-TIL-
4100C NEXT-FAILURE FOR PART J.  JTTL(J) IS THE FLYING HOUR TIME-
4110C TIL-LIFE LIMIT FOR PART J.
4120C R(J) IS RATIO OF EITHER TOTAL ENGINE OPERATING HOURS TO
4130C ENGINE FLYING HOURS OR OF CYCLES PER FLYING HOUR AS APPRO-
4140C PRIATE FOR EACH PART J.
4150C MOT(J) IS INPUT LIFE LIMIT  (MAXIMUM OPERATING TIME) FOR
4160C PART J IN EITHER TOTAL OPERATING HOURS OR CYCLES AS APP.
4170C SHP(J) IS WEIBULL SHAPE PARAMETER (.GE.1.00) .
4180C IF 1.0, FAILURE DISTRIBUTION IS EXPONENTIAL (CONSTANT
4190C ACTUARIAL REMOVAL RATE).  AS SHP(J) INCREASES IN RANGE >
4200C 1.0, < INFINITY, THE FAILURE DISTRIBUTION REFLECTS ACTUARIAL
4210C REMOVAL RATES THAT INCREASE WITH ENGINE AGE.  THE LARGER
4220C ACTUARIAL RATES AT HIGHER AGES.
4230C JSCL(J) IS THE WEIBULL SCALE PARAMETER.  THIS IS SIMILAR
4240C TO AN ACTUARIAL LIFE EXPECTANCY FOR PART J.
4250C ALOC(J) IS THE WEIBULL LOCATION PARAMETER.  IN MOST CASES
4260C THIS PARAMETER WILL BE 0.  ALL PARAMETERS ARE DEFINED IN
4270C THE INPUT DATA IN SUBSECTION 9000.
4280C
4290C SCLE = FLOAT(JSCL(J))
4300C  TTF =ALOC(J)+(SCLE-ALOC(J))*(-ALOG(UNIFM1(SEED)))**(1./SHP(J))
4310C JTTF(J) = IFIX(TTF)
4320C JTTL(J)=IFIX(FLOAT(MOT(J))/R(J))
4330C
4340C RETURN
4350C
4380C SUBSECTION 4100
4390C
```

10. <u>Subsection 4400, Warmup</u>. This section of the program randomizes the starting ages of each part. (Lines 4400 through 4570).

```
4400C WARMUP
4410C
4420C THIS PROGRAM RANDOMIZES THE STARTING AGE OF EACH PART BY
4430C SUBTRACTING OFF A RANDOM SHARE OF THE TIME TIL
4440C FAILURE (OR TIME TO LIFE LIMIT , IF SMALLER).
4450C
4460 4100 DO 4120 J = 1,JJ
4470  RND = UNIFM1(SEED)
4480  IWS = IFIX(RND*FLOAT(JTTF(J)))
4490  IF(JTTF(J).GT.JTTL(J)) IWS = IFIX(RND*FLOAT(JTTL(J)))
4500  JTTL(J) = JTTL(J) - IWS
4510  JTTF(J) = JTTF(J) - IWS
4520 4120 CONTINUE
4530C
4540C RETURN
4550C
4560 GO TO 1
4570C
```

11. <u>Subsection 4200, Minimum Failure and Scheduled Time</u>. This subsection of the program finds the part having the minimum time till failure and which has the minimum time till MOT. (See lines 4200 - 4740).

```
4580C SUBSECTION 4200
4590C
4600C FIND MIN JTTF(J) AND MIN JTTL(J)
4610C
4620 4200 MINF = 10000000
4630  DO 4210 J = 1,JJ
4640  IF(JTTF(J).LT.MINF)  MINF = JTTF(J)
4650 4210 CONTINUE
4660  MINL = 10000000
4670  DO 4220 J = 1,JJ
4680  IF(JTTL(J).LT.MINL)  MINL = JTTL(J)
4690 4220 CONTINUE
4700C
4710C RETURN
4720C
4730  GO TO 10
4740C
```

12. <u>Subsection 4300, Count Multiple Part Removals</u>. This part of the program, lines 4750 through 4880, determines if more than one part is to be removed for failure (due to equal times till failure) or more than one has the same time remaining till MOT removal.

```
4750C SUBSECTION 4300
4760C
4770C COUNT MULTIPLE PART REMOVALS
4780C
4790 4300 MULTF = 0; MULTL = 0
4800   DO 4340 J = 1,JJ
4810   IF(MINF.EQ.JTTF(J))  MULTF = MULTF + 1
4820   IF(MINL.EQ.JTTL(J))  MULTL = MULTL + 1
4830 4340 CONTINUE
4840C
4850C RETURN
4860C
4870 GO TO 22
4880C
```

13. <u>Subsection 4400, Update All Parts to Remaining Time in Report Period</u>. This section of the program, lines 4890 - 5050, simply subtracts the amount of time from all parts that were not removed in order to update them to the time that the removals of the offending parts took place.

```
4890C SUBSECTION 4400
4900C
4910C UPDATE ALL PARTS FOR REMAINING TIME IN THIS K PERIOD
4920C
4930 4400 DO 4410 J = 1,JJ
4940   JTTF(J) = JTTF(J) - K3
4950   JTTL(J) = JTTL(J) - K3
4960 4410 CONTINUE
4970C
4980C RELOAD FULL TIME TO END OF REPORT PERIOD FOR NEXT Z PERIOD
4990C
5000   K3 = IRPTPRD
5010C
5020C RETURN
5030C
5040 GO TO 35
5050C
```

14. Subsection 4600, Report Period Removal Tabulations.

a. This is a large section of the program, lines 5060 through 6910, which contains logic necessary for each report period of the program run. It begins by initializing the removal code arrays for the parts and the modules. Then each part is aged by the minimum time to removal and the time remaining in this report period is decremented by that amount. This part of the program contains the coding logic for each reason for removal of the part in question. These codes are found in lines 5370 through 5530.

b. Next the program assigns a removal code to all removed parts. Immediately following this logic the removal reasons for module removals are determined according to what parts were removed from these modules. When this step is accomplished, the reason for removal of the engine can be determined as well as whether or not the Rule of X Policy applies.

```
5060C SUBSECTION 4600
5070C
5080C IF REMOVAL THIS PERIOD
5090C
5100C INITIALIZE REMOVAL CODE ARRAYS, JPART(J) AND MOD(M).
5110C AND NERC
5120C
5130 4600 DO 4610 J = 1,JJ
5140  JPART(J) = 0
5150 4610 CONTINUE
5160 NERC = 0
5170  DO 4620 M = 1,MM
5180  MOD(M) = 0
5190 4620 CONTINUE
```

```
C
C AGE EACH PART BY MIN TIME TO REMOVAL AND UPDATE TIME
C REMAINING THIS REPORT PERIOD.K3
C
  DO 4640 J = 1,JJ
  IF(MINL.LT.MINF)  GO TO 4630
  JTTF(J) = JTTF(J) - MINF
  JTTL(J) = JTTL(J) - MINF
  GO TO 4640
C SUBTRACT MINIMUM TIME TO REMOVAL FROM ALL FAILURE
C TIMES AND MOT'S FOR ALL PARTS
4630 JTTF(J) = JTTF(J) - MINL
  JTTL(J) = JTTL(J) - MINL
4640 CONTINUE
  IF(MINL.LT.MINF) ICLOCK=ICLOCK+MINL
  IF(MINL.GE.MINF) ICLOCK=ICLOCK+MINF
  IF(MINL.LT.MINF)  K3=K3-MINL
  IF(MINL.GE.MINF)  K3=K3-MINF
C
C FOR EACH PART, IDENTIFY AND CODE REASON FOR REMOVAL
C  CODE 0 = NO DEFECT
C  CODE 1 = USAGE REMOVAL
C  CODE 2 = TOLERANCE REMOVAL (PART IS ABOUT TO FAIL AND IS
C           DETECTED BY MAINTENANCE PERSONNEL)
C  CODE 3 = SCREENED TO DEPOT BECAUSE "CLOSE ENOUGH" TO LIFE
C           LIMIT
C  CODE 4 = LIFE LIMIT REACHED, MOT (MAX OP. TIME) REMOVAL
C  CODE 5 = U-DEP, USAGE REMOVAL, BUT "CLOSE ENOUGH" TO MOT
C           TO SEND TO DEPOT FOR REPAIR
C  CODE 6 = MULTIPLE PARTS, ALL USAGE
C  CODE 7 = MULTIPLE PARTS, WITH AT LEAST ONE SCHEDULED
C  CODE 8 = RULE OF X TO DEPOT
C  CODE 9 = MULTIPLE MODULE REMOVALS, ALL USAGE, NOT RULE OF X
C  CODE 10= MULTIPLE MODULE REMOVALS, AT LEAST ONE SCHEDULED,
C           NOT RULE OF X
C
C JF(M) IS NUMBER OF 1ST PART IN MTH MODULE.  JF(M) ARRAY
C MUST CONTAIN ONE MORE ENTRY THAN NUMBER OF MODULES.  THE
C (M+1)ST ENTRY SHOULD EQUAL ONE PLUS MTH ENTRY INPUT IN SUBS 9000.
C
```

```
      DO 4750 M = 1,MM
      DO 4700 J = JF(M),(JF(M+1)-1)
      ISCRN = FLOAT(MSCRN(M))/R(J)
      IF(JTTL(J).EQ.0)  JPART(J) = 4
      IF(JTTL(J).EQ.0)  GO TO 4700
      IF(JTTF(J).EQ.0.AND.JTTL(J).GT.ISCRN) JPART(J) = 1
      IF(JTTF(J).EQ.0.AND.JTTL(J).LE.ISCRN) JPART(J) = 5
      IF(JTTF(J).GT.0.AND.JTTF(J).LE.JTOL)  JPART(J) = 2
      IF(JTTF(J).GT.0.AND.JTTL(J).LE.ISCRN) JPART(J) = 3
 4700 CONTINUE
 4750 CONTINUE
C
C FOR EACH MODULE, IDENTIFY AND CODE REASON FOR REMOVAL
C
      DO 4800 M = 1,MM
C
C INITIALIZE MULTIPLE PARTS COUNTER, MPC, AND COMPUTE ITS VALUE
C
      MPC=0
      DO 4810 J = JF(M),(JF(M+1)-1)
      IF(JPART(J).GT.0)  MPC = MPC + 1
 4810 CONTINUE
C
C FOR EACH MODULE, SIFT PARTS REASONS FOR REMOVAL
C AND CODE REASON FOR MODULE REMOVAL INTO MOD(M)
C
      DO 4850 J = JF(M),(JF(M+1)-1)
      IF(JPART(J).EQ.0)  GO TO 4850
      IF(MPC.GT.1)  GO TO 4825
      MOD(M) = JPART(J)
      GO TO 4850
 4825 IF(JPART(J).LE.2.AND.MOD(M).LT.7)  MOD(M) = 6
      IF(JPART(J).GT.2.AND.JPART(J).LT.6)  MOD(M) = 7
 4850 CONTINUE
 4800 CONTINUE
C
C DETERMINE ENGINE REMOVAL CODE AND RULE OF X FOR DETERMINING
C DEPOT REPAIR AND STORE IN NERC
C      FOR EXAMPLE, IF X = 3, THEN
C RULE OF 3 SAYS THAT IF 3 OR MORE MODULES (EXCLUDING
C ACCESSORIES-2 AND AUGMENTOR AND INCLUDING THE CORE)
C REQUIRE REMOVAL AT TIME OF THIS ENGINE REMOVAL THEN NRTS
C WHOLE ENGINE TO DEPOT
C
C INITIALIZE MULTIPLE MODULE COUNTER, MMC, AND COMPUTE ITS VALUE
C
```

```
      MMC = 0
      DO 4900 M = 1,MM
      IF(MOD(M).GT.0)  MMC = MMC + 1
 4900 CONTINUE
C
C DETERMINE RULE OF X AND
C DETERMINE REASON FOR ENGINE REMOVAL CODE AND
C STORE CODE IN NERC
C
 IF(MMC.GT.1)  GO TO 4910
C
C SINGLE MODULE REMOVAL
C
      DO 4920 M = 1,MM
      IF(MOD(M).GT.0)  NERC = MOD(M)
 4920 CONTINUE
C
 GO TO 4950
C
C MULTIPLE MODULE REMOVAL
C
C MODULES 1 AND (MM-1) ARE NOT INCLUDED IN RULE OF X
C MODULE 4, CORE, IS MANDATORY INCLUSION IN RULE OF X
C MR3 STORES COUNT OF RULE OF X MODULES HAVING REMOVALS
C
 4910 MR3 = 0
C 6596C COMPUTE TOTAL MANHOURS USED FOR
      DO 4925 M = 2,MM-1
      IF(MOD(M).GT.0)  MR3 = MR3 + 1
 4925 CONTINUE
      IF(MR3.LT.MRULE.OR.MOD(4).LT.1)  GO TO 4930
C
C WHOLE ENGINE SHIPPED TO DEPOT, RULE OF X
C
      NERC = 8
      GO TO 4950
C
C NOT RULE OF X, BUT MULTIPLE MODULE REMOVALS
C
 4930 DO 4940 M = 1,MM
      IF(MOD(M).EQ.0)  GO TO 4940
```

```
      IF((MOD(M).LE.2.OR.MOD(M).EQ.6).AND.NERC.NE.10)  NERC = 9
      IF(MOD(M).GT.2.AND.MOD(M).LT.6)  NERC = 10
      IF(MOD(M).EQ.7)  NERC = 10
 4940 CONTINUE
C IF NERC=8, BYPASS ENGINE BASE SEPARATION COST
C BECAUSE WHOLE ENGINE SHIPPED TO DEPOT WITH NO
C MODULES REMOVED AT BASE
 4950 IF (NERC.EQ.8) GO TO 5090
      IF(MMC.GT.1) GO TO 5010
C SINGLE MODULE REMOVAL
C
C COMPUTE TOTAL MANHOURS SPENT REMOVING LONE MODULE
C
      DO 5020 M = 1 , MM
      IF (MOD(M).GT.0) NBSEPTMH = NBSEPTMH + MBSEPMH(M)
 5020 CONTINUE
      GO TO 5030
 5010 IF(MOD(4).EQ.0) GO TO 5040
C COMPUTE TOTAL MANHOURS USED FOR
C MULTIPLE MODULE REMOVAL INCLUDING CORE
C
      NBSEPTMH = NBSEPTMH + MBSEPMH(4)
      IF(MOD(5).GT.0)   NBSEPTMH = NBSEPTMH + 10
      GO TO 5070
 5040 IF(MOD(5).EQ. 0) GO TO 5050
C MULTIPLE MODULE REMOVAL INCLUDING HPT BUT NOT CORE
      NBSEPTMH = NBSEPTMH + MBSEPMH(5)
      IF (MOD(3).GT.0) NBSEPTMH = NBSEPTMH + MBSEPMH(3)
      IF(MOD(7).GT.0) NBSEPTMH = NBSEPTMH + MBSEPMH(7)
      GO TO 5070
 5050 IF(MOD(6).EQ.0) GO TO 5060
C MULTIPLE MODULE REMOVAL INCLUDING TURBINE BUT NOT CORE NOR HPT
      NBSEPTMH = NBSEPTMH + MBSEPMH(6)
      IF(MOD(2).GT.0) NBSEPTMH = NBSEPTMH + MBSEPMH(2)
      IF (MOD(3).GT.0) NBSEPTMH = NBSEPTMH + MBSEPMH(3)
      IF (MOD(7).GT.0) NBSEPTMH = NBSEPTMH + MBSEPMH(7)
      GO TO 5070
C MULTIPLE MODULE REMOVALS BUT NOT CORE NOR HPT NOR TURBINE
 5060 IF(MOD(1).GT.0) NBSEPTMH = NBSEPTMH + MBSEPMH(1)
      IF(MOD(2).GT.0) NBSEPTMH = NBSEPTMH + MBSEPMH(2)
      IF(MOD(3).GT.0) NBSEPTMH = NBSEPTMH + MBSEPMH(3)
      IF(MOD(7).GT.0) NBSEPTMH = NBSEPTMH + MBSEPMH(7)
C ACC2 REPAIR
 5070 IF(MOD(8).GT.0) NBSEPTMH = NBSEPTMH + MBSEPMH(8)
C ADD MH TO TEST ENGINE
 5030 NBSEPTMH = NBSEPTMH + NBTESTMH
C CONVERT MH TO DOLLARS
      NBSEPCST = IFIX((FLOAT(NBSEPTMH)*BMHCST)+.5)
C BYPASS SINCE ENGINE SHIPPED RULE OF X AND NO MODULES WERE REMOVED AT
C BASE.
C RETURN
 5090 GO TO 50
C
```

15. Subsection 5100, Record Engine Removal. This subsection, lines 6920 through 7770, records engine removals and module removals by report period, and separates these removals as NRTS or RTS.

```
6920C SUBSECTION 5100
6930C
6940C RECORD ENGINE REMOVAL
6950C
6960C BY REPORT PERIOD, K
6970C
6980 5100 IF(NERC.EQ.1)  NGUSE1(K) = NGUSE1(K) + 1
6990  IF(NERC.EQ.2)  NGUSE1(K) = NGUSE1(K) + 1
7000  IF(NERC.EQ.4)  NGTM1(K) = NGTM1(K) + 1
7010  IF(NERC.EQ.5)  NGUSE1(K) = NGUSE1(K) + 1
7020  IF(NERC.EQ.6)  NGUSE1(K) = NGUSE1(K) + 1
7030  IF(NERC.EQ.7)  NGTM1(K) = NGTM1(K) + 1
7040  IF(NERC.EQ.8)  NGTM2(K) = NGTM2(K) + 1
7050  IF(NERC.EQ.9)  NGUSE2(K) = NGUSE2(K) + 1
7060  IF(NERC.EQ.10)  NGTM2(K) = NGTM2(K) +1
7070  NENGTOT = NENGTOT + 1
7080C
7090C RETURN
7100C
7110 GO TO 6.
7120C
7130C RECORD MODULE REMOVALS FOR ENGINE NRTS ANALYSIS
7140C
7150 5105 IF(NERC.EQ.8)  GO TO 5120
7160C
7170C NOT RULE OF Y
7180C
7190  DO 5110 M = 1,NM
7200  IF(MOD(M).EQ.0)  GO TO 5110
7210  IF(MOD(M).EQ.1)  GOTO 5115
7220  IF(MOD(M).EQ.2)  GO TO 5115
7230  IF(MOD(M).EQ.3)  MSCRNRTS(M) = MSCRNRTS(M) + 1
7240  IF(MOD(M).EQ.4)  MSCHNRTS(M) = MSCHNRTS(M) + 1
7250  IF(MOD(M).EQ.5)  MUSNRTS(M) = MUSNRTS(M) + 1
7260  IF(MOD(M).EQ.7)  MSCHNRTS(M) = MSCHNRTS(M) + 1
7270  IF(MOD(M).EQ.6) GO TO 5115
7280  GOTO 5110
```

```
C
C SEPARATE INTO RTS OR NRTS REMOVAL
C
 5115 RND = UNIFM1(SEED)*100.0
      IF(RND.GT.BNRTSPC(M))  MRTS(M) = MRTS(M) + 1
      IF(RND.LE.BNRTSPC(M))  MUNRTS(M) = MUNRTS(M) + 1
 5110 CONTINUE
C
C RETURN
C
 GOTO 70
C
C RULE OF X
C
 5120 NENGNRTS = NENGNRTS + 1
      DO 5130 M = 1,MM
      IF(MOD(M).EQ.0)  MXOKNRTS(M) = MXOKNRTS(M) + 1
 IF(MOD(M).EQ.1)  MXUNRTS(M) = MXUNRTS(M) + 1
      IF(MOD(M).EQ.2)  MXUNRTS(M) = MXUNRTS(M) + 1
      IF(MOD(M).EQ.3)  MXSCRNRT(M) = MXSCRNRT(M) + 1
      IF(MOD(M).EQ.4)  MXSCHNRT(M) = MXSCHNRT(M) + 1
      IF(MOD(M).EQ.5)  MXUSNRTS(M) = MXUSNRTS(M) + 1
      IF(MOD(M).EQ.6)  MXUNRTS(M) = MXUNRTS(M) + 1
      IF(MOD(M).EQ.7)  MXSCHNRT(M) = MXSCHNRT(M) + 1
 5130 CONTINUE
C
C RETURN
C
      GO TO 70
C
C RECORD MODULE LEVEL REMOVALS
C
C BY REPORT PERIOD, K
C
 5135 DO 5140 M = 1,MM
      IF(MOD(M).EQ.0)  GO TO 5140
      IF(MOD(M).EQ.1)  MODUSE1(M,K) = MODUSE1(M,K) + 1
      IF(MOD(M).EQ.2)  MODUSE1(M,K) = MODUSE1(M,K) + 1
      IF(MOD(M).EQ.3)  MODSCR(M,K) = MODSCR(M,K) + 1
      IF(MOD(M).EQ.4)  MODTM1(M,K) = MODTM1(M,K) + 1
      IF(MOD(M).EQ.5)  MODTM1(M,K) = MODTM1(M,K) + 1
      IF(MOD(M).EQ.6)  MODUSE2(M,K) = MODUSE2(M,K) + 1
      IF(MOD(M).EQ.7)  MODTM2(M,K) = MODTM2(M,K) + 1
 5140 CONTINUE
C
C RETURN
C
 GO TO 80
C
```

16. Subsection 5145, Module Removal Summary. This section of the program, lines 7780 through 7960, total all the module removal reasons for primary cause.

```
7780C SUBSECTION 5145
7790C
7800C MODULE REMOVAL SUMMARY ( FOR PRIMARY CAUSE)
7810C
7820 5145 DO 5150 M = 1,MM
7830   IF(MOD(M).EQ.0)   GO TO 5150
7840   IF(MOD(M).EQ.1)   MUSE(M) = MUSE(M) + 1
7850   IF(MOD(M).EQ.2)   MUSE(M) = MUSE(M) + 1
7860   IF(MOD(M).EQ.3)   MSCR(M) = MSCR(M) + 1
7870   IF(MOD(M).EQ.4)   MTM(M) = MTM(M) + 1
7880   IF(MOD(M).EQ.5)   MUD(M) = MUD(M) + 1
7890   IF(MOD(M).EQ.6)   MUSE(M) = MUSE(M) + 1
7900   IF(MOD(M).EQ.7)   MTM(M) = MTM(M) + 1
7910 5150 CONTINUE
7920C
7930C RETURN
7940C
7950  GO TO 90
7960C
```

17. Subsection 5155, Part Removals by Cause. This section, in lines 7970 through 8140, records part level removals by cause.

```
7970C SUBSECTION 5155
7980C
7990C RECORD PART LEVEL REMOVALS BY CAUSE
8000C
8010 5155 DO 5160 J = 1,JJ
8020   IF(JPART(J).EQ.0)   GO TO 5160
8030   IF(JPART(J).EQ.1)   JUSE(J) = JUSE(J) + 1
8040   IF(JPART(J).EQ.2)   JTOLR(J) = JTOLR(J) + 1
8050   IF(JPART(J).EQ.3)   JSCR(J) = JSCR(J) + 1
8060   IF(JPART(J).EQ.3)   JMSCR(J,K) = JMSCR(J,K) + 1
8070   IF(JPART(J).EQ.4)   JTM(J) = JTM(J) + 1
8080   IF(JPART(J).EQ.5)   JUDEP(J) = JUDEP(J) + 1
8090 5160 CONTINUE
8100C
8110C RETURN
8120C
8130 GO TO 95
8140C
```

18. <u>Subsection 5200, Failure and Scheduled Removal Times.</u> This section, lines 8150 through 8310, calculates new removal times through a random number generator, UNIFM1(SEED).

```
8150C SUBSECTION 5200
8160C
8170C
8180 5200 DO 5210 J = 1,JJ
8190  IF(JPART(J).EQ.0)  GO TO 5210
8200C REPLACE
8210C KA = 2;  GO TO 4000
8220  SCLE = FLOAT(JSCL(J))
8230  TTF=ALOC(J)+(SCLE-ALOC(J))*(-ALOG(UNIFM1(SEED)))**(1./SHP(J))
8240  ITTF(J)=IFIX(TTF)
8250  ITL(J)=IFIX(FLOAT(MOT(J))/R(J))
8260 5210 CONTINUE
8270C
8280C RETURN
8290C
8300  GO TO 97
8310C
```

19. <u>Subsection 7000, Totals.</u> This section of the program, in lines 8320 through 9940, calculates all the output for the program. The parts level totals, module removal totals, line totals by report period, total NRTS and RTS for modules and engine are all calculated here.

```
8320C SUBSECTION 7000
8330C
8340C CALCULATE PARTS LEVEL TOTALS
8350C
8360 5300  JUSET=0;JTOLRT=0;JUDEPT=0;JTMT=0;JSCRT=0;JTOTRT=0
8370  DO 5310  M = 1,MM
8380  MJUSET(M)=0;MJTOLRT(M)=0;MJUDEPT(M)=0
8390  MJTMT(M)=0;MJSCRT(M)=0;MJTOTRT(M)=0
8400 5310 CONTINUE
8410C
8420  DO 5320 J= 1,JJ
8430  JTOTR(J) = JUSE(J) + JTOLR(J) + JUDEP(J) + JTM(J) + JSCR(J)
8440 5320 CONTINUE
8450C
```

```
      DO 5330 M = 1,MM
      DO 5340 J =  JF(M),JF(M+1)-1
      MJUSET(M) = MJUSET(M) + JUSE(J)
      MJTOLRT(M) = MJTOLRT(M) + JTOLR(J)
      MJUDEPT(M) = MJUDEPT(M) + JUDEP(J)
      MJTMT(M) = MJTMT(M) + JTM(J)
      MJSCRT(M) = MJSCRT(M) + JSCR(J)
      MJTOTRT(M) = MJTOTRT(M) + JTOTR(J)
 5340 CONTINUE
 5330 CONTINUE
C
      DO 5350 M = 1,MM
      JUSET = JUSET + MJUSET(M)
      JTOLRT = JTOLRT + MJTOLRT(M)
      JUDEPT = JUDEPT + MJUDEPT(M)
      JTMT = JTMT + MJTMT(M)
      JSCRT = JSCRT + MJSCRT(M)
      JTOTRT = JTOTRT + MJTOTRT(M)
 5350 CONTINUE
C
C CALCULATE MODULE REMOVAL TOTALS
C
      MUSET=0;MUDT=0;MTMT=0
      MSCRT=0;MTOTRT=0;MMTUSE2=0;MMTTM2=0
      MRTST=0;MUNRTST=0;MUSNRTST=0;MSCHNRTT=0
      MSCRNRTT=0;MTNRTST=0;MXUNRTST=0;MXUSNRTT=0
      MXSCHNTT=0;MXSCRNTT=0;MXOKNRTT=0;MNRWTHTL=0
C
 5360 DO 5370 M = 1,MM
      MTOTR(M)=0
      MTOTR(M) = MUSE(M)+MUD(M)+MTM(M)+MSCR(M)
 5370 CONTINUE
C

      DO 5380 M = 1,MM
      MUSET = MUSET + MUSE(M)
      MAUSE(M)=MAUSE(M)+MUSE(M)
      MUDT = MUDT + MUD(M)
      MAUD(M)=MAUD(M)+MUD(M)
      MTMT = MTMT + MTM(M)
      MATM(M)=MATM(M)+MTM(M)
      MSCRT = MSCRT + MSCR(M)
      MASCR(M)=MASCR(M)+MSCR(M)
      MTOTRT = MTOTRT + MTOTR(M)
      MRTST = MRTST + MRTS(M)
      MUNRTST = MUNRTST + MUNRTS(M)
      MUSNRTST = MUSNRTST + MUSNRTS(M)
```

```
      MSCHNRTT = MSCHNRTT + MSCHNRTS(M)
      MSCRNRTT = MSCRNRTT + MSCRNRTS(M)
      MXUNRTST = MXUNRTST + MXUNRTS(M)
      MXUSNRTT = MXUSNRTT + MXUSNRTS(M)
      MXSCHNTT = MXSCHNTT + MXSCHNRT(M)
      MXSCRNTT = MXSCRNTT + MXSCRNRT(M)
      MXOKNRTT = MXOKNRTT + MXOKNRTS(M)
      MNRTSWTH(M) = MXUNRTS(M)+MXUSNRTS(M)+MXSCHNRT(M)+MXSCRNRT(M)
      MNRWTHTL = MNRWTHTL + MNRTSWTH(M)
 5380 CONTINUE
C
C CALCULATE (M,K) LINE TOTALS
C
 5430 DO 5440 K = 1,KLAST
      DO 5450 M = 1,MM
      MODTOTR(M,K) = MODUSE1(M,K)+MODUSE2(M,K)+MODTM2(M,K)+MODTM1(M,K)+
     &MODSCR(M,K)
 5450 CONTINUE
 5440 CONTINUE
C
C CALCULATE (M,K) M TOTALS
C
 5460 DO 5470 M = 1,MM
      MTUSE1(M)=0;MTUSE2(M)=0;MTTM2(M)=0;MTTM1(M)=0
      MTTOTR(M)=0;MTSCR(M)=0
      DO 5480 K = 1,KLAST
      MTUSE1(M) = MTUSE1(M) + MODUSE1(M,K)
      MTUSE2(M) = MTUSE2(M) + MODUSE2(M,K)
      MTTM2(M) = MTTM2(M) +MODTM2(M,K)
      MTTM1(M) = MTTM1(M) + MODTM1(M,K)
      MTTOTR(M) = MTTOTR(M) + MODTOTR(M,K)
      MTSCR(M) = MTSCR(M) + MODSCR(M,K)
 5480 CONTINUE
 5470 CONTINUE
C  COMPUTE TOTAL NRTS BY MODULE
 5540 DO 5550 M = 1,MM
      MTNRTS(M)=MUNRTS(M)+MUSNRTS(M)+MSCHNRTS(M)+MSCRNRTS(M)
      MTNRTST = MTNRTST + MTNRTS(M)
 5550 CONTINUE
C
C COMPUTE FINAL REM/1000FH BY MODULE (ALONE ONLY=FRKFH(M))
C       DEPOT ONLY=FRKFHD(M);    TOTAL FOR CAUSE=FRKFHC(M)
C
 5490 DO 5500 M = 1,MM
      FRKFH(M) = (1000.0*FLOAT(MRTS(M)+MTNRTS(M)))/FLOAT(ISIMPRD)
      FKFH(M)=FKFH(M)+FRKFH(M)
      FRKFHD(M)=(1000.0*FLOAT(MNRTSWTH(M)))/FLOAT(ISIMPRD)




      FRKFHC(M)=FRKFH(M)+FRKFHD(M)
 5500 CONTINUE
```

```
C
C CALCULATE FINAL NRTS% BY MODULE
C  BASE LEVEL NRTS%=BNRTSPC(M); DEPOT LEVEL REMOVAL %=DEPPC(M)
C  TOTAL REMOVALS FOR CAUSE, %REPAIRED AT DEPOT=TOTPC(M)
C
   DO 5510 M = 1,MM
  IF(FLOAT(MRTS(M)+MTNRTS(M)).EQ.0) GOTO 5510
   FNRTSPC(M) = (100.0*FLOAT(MTNRTS(M)))/FLOAT(MRTS(M)+MTNRTS(M))
   FNRTS(M)=FNRTS(M)+FNRTSPC(M)
   DEPPC(M) = 100.00
   TOP = MTNRTS(M) + MNRTSWTH(M)
   BOTTOM = TOP + FLOAT(MRTS(M))
   TOTPC(M) = 100.0*TOP/BOTTOM
 5510 CONTINUE
C
C COMPUTE ENGINE NRTS%
C
 5520 ENRTSPC = 100.0*FLOAT(NENGNRTS)/FLOAT(NENGTOT)
   ENRTSPCT=ENRTSPCT+ENRTSPC
   IF(ISMAX.EQ.ISDRUN) EANRTS=ENRTSPCT/FLOAT(ISMAX)
C
C COMPUTE ENGINE REM/1000FH
C
 5530 ERKFH = 1000.0*FLOAT(NENGTOT)/FLOAT(ISIMPRD)
   ERKFHT=ERKFHT+ERKFH
   IF(ISMAX.EQ.ISDRUN) EAFH=ERKFHT/FLOAT(ISMAX)
C
C COMPUTE ENGINE REMOVAL LINE TOTALS FOR EACH K PERIOD
C
  DO 5560 K = 1,KLAST
   NGTOTR(K)=NGUSE1(K)+NGUSE2(K)+NGTM2(K)+NGTM1(K)
 5560 CONTINUE
C
C COMPUTE ENGINE REMOVAL COLUMN TOTALS OVER ALL K PERIODS
C
 5570 NGUSE1T=0;NGUSE2T=0;NGTM2T=0;NGTM1T=0;NGTOTRT=0
C
   DO 5580 K = 1,KLAST
   NGUSE1T = NGUSE1T + NGUSE1(K)
   NGT2(K)=NGT2(K)+NGTM2(K)
   NGU1(K)=NGU1(K)+NGUSE1(K)
   NGU2(K)=NGU2(K)+NGUSE2(K)
   NGT1(K)=NGT1(K)+NGTM1(K)
   NGUSE2T = NGUSE2T + NGUSE2(K)
   NGTM2T = NGTM2T + NGTM2(K)
   NGTM1T = NGTM1T + NGTM1(K)
   NGTOTRT = NGTOTRT + NGTOTR(K)
 5580 CONTINUE
   IOBFNAX=IOBFNAX+NGTOTRT
C
C RETURN
C
   GO TO 105
C
```

20. Subsection 5220, Output Tables. This routine generates the majority of the output tables for the program and is found in lines 9950 through 13580.

```
9950C SUBSECTION 5220
9960C
9970C OUTPUT ROUTINES -- REMOVALS TABLES
9980C



9990C  CROSS REFERENCE TABLE (PAGE 1 OF LONG OR SHORT FORM)
10000C
10010 5600 IPG = IPG+1
10020   PRINT 5610
10030 5610 FORMAT("1",/////)
10040   PRINT 5620,ISDRUN,IPG
10050 5620 FORMAT(1H0,"SEED RUN ",I2,4X,">> ","CROSS REFERENCE TABLE",
10060&" <<",5X,"PAGE ",I4)
10070   PRINT 5630,ENGINE
10080 5630 FORMAT(1H0,T20,A15)
10090   PRINT 5640,XDATE,FTIME,LTIME
10100 5640 FORMAT(1H0,"DATA",A8,12X,12X,"TIME",F7.2," SEC ",I2)
10110   PRINT 5650,KONPER,KPSCRN
10120 5650 FORMAT(1H0,"MODULE",6X,"MODULE",6X,A8,1X,A8," SCREEN",
10130&2X,"MONTHS")
10140   PRINT 5660
10150 5660 FORMAT(" ","  NO.",3X,"NOMENCLATURE",5X,"SCREEN",3X,
10160&"INTRVL  IN",1X,"EFH  REMAIN")
10170   PRINT 5670
10180 5670 FORMAT(1H ,5("="),1X,15("="),2X,8("="),3("  ------")&//)
10190 DO 5680 M=1,MM
10200   MMM = JF(M+1)-1
10210   IF(MMM.LT.1) RFACTOR = R(1)
10220   IF(MMM.GE.1) RFACTOR = R(MMM)
10230   SCRINEFH = FLOAT(MSCRN(M))/RFACTOR
10240   AMONREM = SCRINEFH/FLOAT(MONUTB)
10250   PRINT 5690,M,MODULE(M),KPV(M),MSCRN(M),SCRINEFH,AMONREM
10260 5690 FORMAT(" ",I4,4X,A14,3X,I5,2X,I7,1X,F8.1,1X,F7.2)
10270 5680 CONTINUE
10280   PRINT 5695,MRULE
10290 5695 FORMAT(1H0,"RULE OF X WAS",I2)
10300C
```

AD-A072 516 AIR FORCE LOGISTICS COMMAND WRIGHT-PATTERSON AFB OH D--ETC F/G 21/5
OPPORTUNISTIC MAINTENANCE ENGINE SIMULATIONN MODEL; OMENS II.(U)
JUN 79 J L MADDEN, P A PERSENSKY

UNCLASSIFIED AFLC/XRS-79-137-1 NL

2 OF 2

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END
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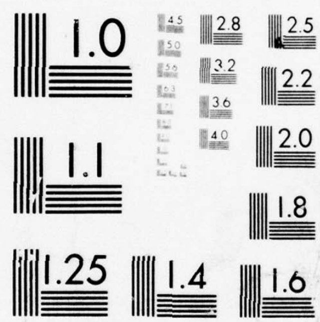

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

```
C ENGINE REMOVALS, REPORT PERIOD,K, SUMMARY
C
C PAGE 2 OF LONG OR SHORT FORM & PAGE 1 OF AVERAGED
C
 5700 IF(IAVG.EQ.1) GO TO 5705
  PRINT 5702
 5702 FORMAT("1",//)
C
 5705 IPG = IPG+1
  PRINT 5710,IPG
 5710 FORMAT("0",T29,"ENGINE REMOVALS",10X,"PAGE ",I4)
  PRINT 5715
 5715 FORMAT (1H0,T26,"REPORT PERIOD SUMMARY")
 PRINT 5720
 5720 FORMAT(1H0,T29,"F100PW100 (F15)")
  PRINT 5725
 5725 FORMAT(1H ,T28,17("_"))
  PRINT 5730,ISDRUN
 5730 FORMAT(1H0,"SEED RUN",I2,40X,"INPUT   OUTPUT")
  PRINT 5740,BERKFH,ERKFH
 5740 FORMAT(1H ,T40,"REM/1000FH",2F9.0)
  PRINT 5750,ISIMPRD,BENRTSPC,ENRTSPC
 5750 FORMAT(1H ,"SIMULATION PERIOD IS",I7,T42,"NRTS %",3X,F6.2,3X,F6.2)
  PRINT 5760,IRPTPRD
 5760 FORMAT(1H ,"REPORT PERIOD IS",5X,I7)
  PRINT 5770,LFCYC
 5770 FORMAT(1H ,"LIFE PERIOD FOR OBJECTIVE FUNCTION IS ",I5," YEARS")
  PRINT 5780,MONUTR
 5780 FORMAT(1H ,"MONTHLY UTILIZATION RATE IS ",I5," FLYING HOURS")
  PRINT 5790,WARMUP
 5790 FORMAT(1H ,"WARMUP   ",A3)
  PRINT 5800,SDTYP
 5800 FORMAT(1H ,"SEED IS ",A8)
  PRINT 5810,MM,MRULE
 5810 FORMAT(1H ,"NUMBER OF MODULES ",I2,8X,"RULE OF X WAS ",I2,//)
  PRINT 5820
 5820 FORMAT(1H ,T22,"ENGINE REMOVALS")
  PRINT 5830
 5830 FORMAT(1H ,T11,39("-"))
  PRINT 5840
 5840 FORMAT(1H ,T12,"* * USAGE * * *   ... TIME ...")
  PRINT 5850
 5850 FORMAT(1H ," REPORT   ONE MOD.  MANY    MANY    ONE")
  PRINT 5860
 5860 FORMAT(1H ," PERIOD      FAILS     MODS.    MODS.    MOT")
  PRINT 5870
 5870 FORMAT(1H ," K  HOURS  EARLY    EARLY    U+T   REACHED    TOTAL")
  PRINT 5875
 5875 FORMAT(1H ,3("-"),1X,5("-"),1X,8("-"),2X,5("-"),2X,5("-"),
&2X,7("-"),3X,5("-"),//)
 5880 FORMAT(1H ,I2,1X,I6,1X,I4,5X,I4,4X,I4,3X,I4,5X,I5)
```

```
10800C
10810C PRINT DATA LINES
10820C
10830  DO 5890 K = 1,KLASE
10840  PRINT 5880,K,K*IBPIPRD,NGUSE1(K),NGUSE2(K),NGTM2(K),NGTM2(K),
10850$ NGTOTE(K)
10860 5890 CONTINUE
10870C
10880C PRINT TOTALS
10890C
10900  PRINT 5905
10910 5905 FORMAT(1H ,11X,4("="),5X,4("="),4X,4("="),
10920&2(4X,4("=")))
10930  PRINT 5910,NGUSE1T,NGUSE2T,NGTM2T,NGTM1T,NGTOTRT
10940 5910 FORMAT (1H ,"TOTALS",3X,I5,4X,I5,3X,I5,2X,I5,4X,I6,//)
10950C
10960  IF(IAVG.EQ.0) GO TO 5920
10970C
10980  PRINT 5915,IOBFNKX
10990 5915 FORMAT("0","SEED TOTAL ",I9)
11000  GO TO 9993
11010C
11020C ENGINE NRTS ANALYSIS, NRTS ALONE
11022C
11025C  TOP OF PAGE 3 OF LONG OR SHORT FORM NOT AVERAGED
11030C
11040C HEADING
11050 5920 IPG = IPG+1
11060 5925 PRINT 5930,IPG
11070 5930 FORMAT(1H1,T27,"ENGINE NRTS ANALYSIS",15X,"PAGE ",I4)
11080  PRINT 5940
11090 5940 FORMAT(1H0,T21,"DISTRIBUTION OF MODULE REMOVALS")
11100  PRINT 5950
11110 5950 FORMAT(1H0,T23,"(NRTS RETURN TO DEPOT ALONE)")
11120  PRINT 5960
11130 5960 FORMAT(1H0,6X,"BASE INITIAL USAGE U-SCREEN SCHED S",
11140&"CREEN TOTAL FINAL NRTS  REM/ ")



11150  PRINT 5970
11160 5970 FORMAT(1H ,"ITEM   RTS  NRTSX  NRTS    ",4("NRTS   "),
11170&" % ALONE  1000FH")
11180  PRINT 5980
11190 5980 FORMAT(1H ,"----  -----",1X,7("-"),1X,5("-"),1X,8("-"),1X,
11200&5("-"),1X,6("-"),1X,5("-"),1X,10("-"),2X,6("-"),//)
11210C
11220C OUTPUT LINES
11230C
```

```
5990 DO 6000 M = 1,MM
      PRINT 6010,M,MRTS(M),BNRTSPC(M),MUNRTS(M),MUSNRTS(M),
$MSCHNRTS(M),MSCRNRTS(M),MINRTS(M),FNRTSPC(M),FRKFH(M)
6000 CONTINUE
6010 FORMAT(1H ,1X,I2,3X,I4,1X,F6.2,2X,I4,4X,I4,3X,I4,
$3X,I4,1X,I5,3X,F5.2,3X,F8.4)
      PRINT 6012,MRTST,MUNRTST,MUSNRTST,
$MSCHNRTT,MSCRNRTT,MINRTST
 6012 FORMAT (1H0,"TOTAL ",I4,9X,I4,4X,I4,3X,I4,
$3X,I4,1X,I5,///)
C
C ENGINE NRTS ANALYSIS, NRTS WITH ENGINE
C
C  LAST HALF OF PAGE 3 LONG AND SHORT FORM NOT AVERAGED
C
C HEADING
      GO TO 6035
      IPG = IPG+1
6020 PRINT 6030,IPG
6030 FORMAT(1H1,T27,"ENGINE NRTS ANALYSIS",10X,"PAGE ",I4)
6035 PRINT 6038
6038 FORMAT("0")
      PRINT 6040
6040 FORMAT(1H0,T21,"DISTRIBUTION OF MODULE REMOVALS")
      PRINT 6050
6050 FORMAT(1H0,T22,"NRTS WITH ENGINE NRTS POLICY")
      PRINT 6060
6060 FORMAT(1H0,T16,"USAGE   U-SCREEN  SCHED  S",
$"CREEN  TOTAL  NOT AFFECTED")
      PRINT 6070
6070 FORMAT(1H ,4X,"ITEM",6X,"NRTS",6X,4("NRTS    "),"BUT NRTS")
      PRINT 6080
6080 FORMAT(1H ,4X,"----",6X,"------",3X,8("-"),2X,"------ --",
$"---- ",3X,"------",2X,12("-"),///)
C
C OUTPUT LINES
C
6090 DO 6100 M = 1,MM
      PRINT 6110,M,MXUNRTS(M),MXUSNRTS(M),MXSCHNRT(M),
$MXSCRNRT(M),MNRTSWTH(M),MXOKNRTS(M)
6100 CONTINUE
6110 FORMAT(1H ,5X,I2,7X,I4,5X,I4,4X,I4,4X,I4,4X,I4,7X,I4)
      PRINT 6115,MXUNRTST,MXUSNRTT,MXSCHNTT,
$MXSCRNTT,MNRWTHTL,MXOKNRTT
 6115 FORMAT (1H0,"TOTAL",9X,I4,5X,I4,4X,I4,4X,I4,
$4X,I4,7X,I4,///)
C
C FOOTNOTES
C
      PRINT 6120,NENGNRTS
6120 FORMAT(1H0,3X,"TOTAL ENGINE NRTS",13X,I5)
```

```
      PRINT 6130,ENRISPC
 6130 FORMAT(1H ,9X,"ENGINE NRTS %",8X,F6.2)
      PRINT 6140,ERKFH
 6140 FORMAT(1H ,3X,"TOTAL REM/1000FH",11X,F8.4,///)
C
C     MODULE REMOVALS BY K PERIOD
C
C      PAGES 4 THRU 11 LONG FORM ELSE NOT PRINTED
C
      IF(IP.EQ.1) GO TO 6400
 6150 DO 6160 M = 1,MM
C     HEADING
      IPG = IPG+1
      PRINT 6170,IPG
 6170 FORMAT(1H1,T29,"MODULE REMOVALS",10X,"PAGE ",I4)
      PRINT 6180
 6180 FORMAT(1H ,T26,"REPORT PERIOD SUMMARY")
      PRINT 6190,MODULE(M)
 6190 FORMAT(1H0,T29,A14)
      PRINT 6200
 6200 FORMAT(1H ,T28,15("*"))
      PRINT 6210,ISDRUN
 6210 FORMAT(1H0,"SEED RUN",8X,I2)
      PRINT 6220,MSCRN(M),KPSCRN
 6220  FORMAT(1H ,"SCREEN IS ",I4,":    TYPE IS   ",A8)
      PRINT 6230,JP(M+1)-JP(M)
 6230  FORMAT(1H ,"NUMBER OF PARTS",3X,I2)
      PRINT 6240,MONUTR
 6240 FORMAT(1H ,"MONTHLY UTILIZATION RATE IS", I5)
      PRINT 6250,IRPTPRD
 6250 FORMAT(1H ,"REPORT PERIOD IS ",I7)
C
C
 6260  PRINT 6270
 6270 FORMAT(1H0,T15,"MODULE REMOVALS (ALONE + NRTS WITH ENGINE)")
      PRINT 6280
 6280 FORMAT(1H ,T11,49("-"))
      PRINT 6290
 6290 FORMAT(1H ,T11,"* * USAGE * * *      ... TIME ...")
      PRINT 6300
 6300 FORMAT(1H ," REPORT   ONE PART  MANY    MANY    ONE",7X,
     $"PARTS")
      PRINT 6310
 6310 FORMAT(1H ," PERIOD    FAILS    PARTS   PRTS    MOT",5X,
     $"SCREENED")
      PRINT 6320
 6320 FORMAT(1H ," K HOURS   EARLY    EARLY   U+T   REACHED",6X,
     $"OUT",1X,"   TOTAL")
      PRINT 6325
 6325 FORMAT(1H ,2("-"),1X,6("-"),1X,8("-"),1X,7("-"),1X,6("-"),1X,
     $8("-"),2X,8("-"),2X,5("-"),///)
C
```

```
C LINE PRINT
C
  DO 6330 K = 1,KLAST
  PRINT 6340,K,K*IRPTPRD,MODUSE1(M,K),MODUSE2(M,K),
$MODTM2(M,K),MODTM1(M,K),MODSCR(M,K),MODTOTR(M,K)
6340 FORMAT(1H ,I2,1X,I6,1X,I5,4X,I5,2X,I5,3X,I5,4X,I5,4X,I5)
6330 CONTINUE
C



C TOTALS COMP & PRINT
C
  PRINT 6350,MTUSE1(M),MTUSE2(M),MTTM2(M),MTTM1(M),MTSCR(M),MTTOTR(M)
6350 FORMAT(1H0," TOTALS",T12,I5,4X,I5,2X,I5,3X,I5,4X,I5,8X,I5,///)
  PRINT 6355
6355 FORMAT(1H0,T16,"INPUT   * * * * * FINAL ",
$"* * * * * *")
  PRINT 6360
6360 FORMAT(" ",T17,"BASE      BASE     DEPOT  TOTAL FOR")
  PRINT 6370
6370 FORMAT(" ",T16,"LEVEL    LEVEL     LEVEL    CAUSE")
  PRINT 6380,BRKFH(M),FRKFH(M),FRKFHD(M),FRKFHC(M)
6380 FORMAT(1H0,"REM/1000EFH ",4(1X,F8.4))
  PRINT 6390,BNRTSPC(M),FNRTSPC(M)
6390 FORMAT(" ","ARTS PERCENT",1X,F6.2,3X,F6.2)
  PRINT 6395,DEPPC(M),TOTPC(M)
6395 FORMAT(" ","% DEP REPAIR",19X,F6.2,3X,F6.2,////)
6160 CONTINUE
C
C  MODULE REMOVAL SUMMARY
C
C  PAGE 12 LONG - PAGE 4 SHORT - PAGE 2 AVERAGED
C
C
6400 IPG = IPG+1
  IF(IAVG.EQ.2) GO TO 6408
C
  PRINT 6405
6405 FORMAT("1",//)
C
6408 PRINT 6410
6410 FORMAT("0",////)
C
```

```
6415  PRINT 6420,IPG
6420 FORMAT(1H0,T18,"MODULE REMOVALS SUMMARY",8X,"PAGE ",I4)
      PRINT 6425,XDATE,FTIME,LTIME
6425 FORMAT(1H0,"DATE ",A8,T41,"TIME ",F5.2," SEC ",I2)
      PRINT 6430,KPSCRN
6430 FORMAT(1H0,T7,"MODULE",T20,"* * * PRIMARY * * * *",
$10X,A8)
      PRINT 6440
6440 FORMAT(1H ," M NOMENCLATURE   USE U-DEP TIME SCREEN",
$"   TOTAL  INTERVAL")
      PRINT 6450
6450 FORMAT(1H ,"--",1X,14("--"),1X,21("-"),3X,5("-"),2X,
$8("-"),//)
6455 DO 6460 M = 1,MM
      PRINT 6470,M,MODULE(M),MUSE(M),MUD(M),MTM(M),MSCR(M),
$MTOTS(M),MSCRN(M)
6470 FORMAT(1H ,I2,1X,A14,I4,1X,I4,2X,I4,2X,I4,4X,I5,3X,I8)
6460 CONTINUE
C
      GO TO 6478
C
C     TOTALS LINE
C
C
6475 MAUSET=MAUSET+MUSET
      MAUDT =MAUDT+MUDT
      MATMT=MATMT+MTMT
      MASCRT=MASCRT+MSCRT
      MXTOT=MXTOT+MTOTST
C
      GO TO 6485
C
6478 PRINT 6480,MUSET,MUDT,MTMT,MSCRT,MTOTRT
6480 FORMAT(1H0,"GRAND TOTAL",T19,I4,1X,I4,2X,I4,2X,I4,4X,I5,///)
C
      IF(IAVG.GT.1) GO TO 6490
      GO TO 6475
C
C
C
6485 IF(IP.EQ.1) GO TO 6595
      GO TO 6500
C
6490 IF(ISMAX.EQ.1) GO TO 9497
C
      PRINT 6495,MAUSET,MAUDT,MATMT,MASCRT,MXTOT
6495 FORMAT("0","SEED TOTALS ",T7,4(2X,I5))
C
GO TO 9993
```

```
C
C PART REMOVAL SUMMARIES
C
C SUMMARY BY MODULE
C
6500 DO 6510 M = 1,MM
C HEADINGS
 IF (M.EQ.01) GO TO 6505
 IF (M.LT.04) GO TO 6515
 IF (M.EQ.05) GO TO 6515
 IF (M.GT.06) GO TO 6515
6505 IPG = IPG+1
 PRINT 6508,IPG
6508 FORMAT(1H1,T25,"PARTS REMOVAL SUMMARY",15X,"PAGE ",I4)
6515 PRINT 6520,MODULE(M)
6520 FORMAT(1H0,2X,14X,9X,">>>",A15)
 PRINT 6530,KPSCRN
6530 FORMAT(1H0,"PART",5X,"PART",8X,8("* "),"REMOVALS",7(" *"),
$3X,A8)
 PRINT 6540
6540 FORMAT(1H ,"NO. J    NAME",8X,"USAGE TOLERANCE U-DEP TIME",
$" SCREEN TOTAL",3X,"SCREEN")
 PRINT 6550
6550 FORMAT(1H ,"------",1X,14("-"),(" -----"),1X,9("-"),
$4(" -----"),2X,8("-"),//)
C LINE PRINT
 ISSCRN = 0
 DO 6560 J=JF(M),JF(M+1)-1
 IF(KPI.EQ.0) ISSCRN = KPV(M)
 IF(KPI.EQ.1) ISSCRN = JPMOT(J)
 PRINT 6570,J,PART(J),JUSE(J),JTOLR(J),JUDEP(J),JTM(J),JSCR(J),
$ JTOTR(J),ISSCRN
6570 FORMAT(1H ,I3,3X,A14,1X,I4,2X,I6,3X,3(I4,2X),I5,3X,I6)
6560 CONTINUE
C  SUBTOTAL PRINT
 PRINT 6580,MJUSET(M),MJTOLRT(M),MJUDEPT(M),MJTMT(M),
$ MJSCRT(M),MJTOTRT(M)
6580 FORMAT(1H0,"MODULE TOTALS",T23,I4,2X,I6,3X,3(I4,2X),I5,///)


6510 CONTINUE
C
C GRAND TOTAL PARTS
C
 PRINT 6590,JUSET,JTOLRT,JUDEPT,JTMT,JSCRT,JTOTRT
6590 FORMAT(1H0,"GRAND TOTALS",T23,I4,2X,I6,3X,3(I4,2X),I5)
C
C RETURN
C
6595 GO TO 106
C
```

21. <u>Subsection 7500, Logic for Objective Function</u>. This part of the program computes the values needed to form the objective function of the program. See lines 13590 through 14720.

```
13590C  SUBSECTION 7500
13600C
13610C   PRE OUTPUT -- OBJECTIVE FUNCTION
13620C
13630C     PARTS REPLACEMENT COSTS
13640C
13650 7300 NGTLCPCS = 0
13660  DO 7305 M = 1,MM
13670  MGTLCPCS(M) = 0
13680  DO 7310 J = JF(M),JF(M+1)-1
13690  JTPSCHD(J) = JUDEP(J) + JTM(J) + JSCR(J)
13700  RLCPSCHD(J) = FLOAT(LFCYC)/FLOAT(ISIMYRS)*FLOAT(JTPSCHD(J))
13710  JTLCPCST(J) = RLCPSCHD(J)*FLOAT(JSLP(J))
13720  MGTLCPCS(M) = MGTLCPCS(M) + JTLCPCST(J)
13730 7310 CONTINUE
13740  MXGPCS(M)=MXGPCS(M)+MGTLCPCS(M)
13750  NGTLCPCS = NGTLCPCS + MGTLCPCS(M)
13760 7305 CONTINUE
13770  NXPCST=NXPCST+NGTLCPCS
13780C
13790C  MODULE PIPELINE COSTS
13800C
13810  MTPIPCST = 0
13820 7320 DO 7330 M = 1,MM
13830  DLCMDDR(M) = FLOAT(MONUTR)/DCONVR*FRKPH(M)
13840  PIPEQTYM(M) = DLCMDDR(M)*(1.0/100.0)*(FNRTSPC(M)*FLOA
13850ST(MDPIPE(M))+(100.0-FNRTSPC(M))*FLOAT(MBPIPE(M)))
13860  MPIPCST(M) = PIPEQTYM(M)*FLOAT(MSLP(M))
13870  MXPIP(M)=MXPIP(M)+MPIPCST(M)
13880  MTPIPCST = MTPIPCST + MPIPCST(M)
13890 7330 CONTINUE
13900C
13910C  MODULE MAINTENANCE COSTS
13920C
```

```
13930   LCTMCST= 0;LCTMCST1=0;LCTMCST3=0;LCTMCST4=0;LCTMCST2=0
13940 7340 DO 7350 M = 1,MM
13950   FACNRTSW(M)=FLOAT(LFCYC)/FLOAT(ISIMYRS)*FLOAT(MNRTSWTH(M))
13960   FACMNRTS(M)=FLOAT(LFCYC)/FLOAT(ISIMYRS)*FLOAT(MTNRTS(M))
13970   FACMRTS(M)=FLOAT(LFCYC)/FLOAT(ISIMYRS)*FLOAT(MRTS(M))
13980   LCMCST1(M)=FACMNRTS(M)*FLOAT(MDPCST(M))
13990   LCMCST2(M)=FACMRTS(M)*FLOAT(MBSCST(M))
14000   LCMCST3(M)=FACNRTSW(M)*FLOAT(MDPCST(M))
14010   LXCST3(M)=LXCST3(M)+LCMCST3(M)
14020   LXCST2(M)=LXCST2(M)+LCMCST2(M)
14030   LXCST1(M)=LXCST1(M)+LCMCST1(M)
14040   LCMCST(M)=LCMCST1(M)+LCMCST2(M)
14050   LXCST(M)=LXCST(M)+LCMCST(M)
14060   LCTMCST=LCTMCST+LCMCST(M)
14070   LCST4(M)=LCMCST1(M)+LCMCST3(M)+LCMCST2(M)
14080   LCTMCST1=LCTMCST1+LCMCST1(M)
14090   LCTMCST3=LCTMCST3+LCMCST3(M)
14100   LCTMCST4=LCTMCST4+LCST4(M)
14110   LCTMCST2=LCTMCST2+LCMCST2(M)
14120 7350 CONTINUE
14130C
14140C  COMPLETE ENGINE COSTS
14150C
14160 7360 ELCRRTS=FLOAT(LFCYC)/FLOAT(ISIMYRS)*FLOAT(NENGNRTS)
14170   ELTOTRT=FLOAT(LFCYC)/FLOAT(ISIMYRS)*FLOAT(NGTOTRT)
14180   NLCDPCST=IFIX(ELCNRTS*FLOAT(NDPCST))
14190   NENGBASE=NGTOTRT-NENGNRTS
14200   ELCBASE=FLOAT(LFCYC)/FLOAT(ISIMYRS)*FLOAT(NENGBASE)
14210 NXDEPO=NXDEPO+NLCDPCST
14220   NLNBSCST=IFIX(ELCBASE*FLOAT(NBSCST))
14230   NAVBCST=NBSEPCST/NENGBASE
14240 LNAVBCST=NBSEPCST*LFCYC/ISIMYRS
14250 NLCBSCST=LCTECST*LFCYC/ISIMYRS
14260 NLCRRTST=IFIX(ELTOTRT)*NBSEST
14270 LCTECST=NLCRRTST+LNAVBCST+NLCDPCST
14280   NRRCST=LCTECST/NGTOTRT*ISIMYRS/LFCYC
14290   LXECST=LXECST+LCTECST
14300 NTCBSCST=NLCRRTST+LNAVBCST
14310 NXBASE=NXBASE+NTCBSCST
14320   ELCDDR=ERKFH*FLOAT(MONUTR)/DCOMVR
```

```
      ERTSPC=100.0-ENRTSPC
      EPIPEQTY=ELCDDR*((ENRTSPC/100.0)*NDPIPE+
$(ERTSPC/100.0)*NBPIPE)
      NTPIPCST=EPIPEQTY*FLOAT(NSLP)
      NXPIP=NXPIP+NTPIPCST
C
C      TRANSPORTATION COST
C
      LCMTTRAN=0;LCGTTRAN=0
      LCNTRANS=IFIX(ELCNRTS*FLOAT(NTRCST))
 7365 DO 7368 M=1,MM
      LCMTRANS(M)=IFIX(FACMNRTS(M)*FLOAT(MTRCST(M)))
      MXTRCST(M)=MXTRCST(M)+LCMTRANS(M)
      LCMTTRAN=LCMTTRAN+LCMTRANS(M)
 7368 CONTINUE
      NXTRAN=NXTRAN+LCNTRANS
      LCGTTRAN=LCNTRANS+LCMTTRAN
      MXTRAN=MXTRAN+LCGTTRAN
C
C      OBJECTIVE FUNCTION SUMMARY
C
 7370 NOBFNCST=LCTECST+NTPIPCST+LCNTRANS
      IOBFNTOT=0;ILCMCST=LCTECST
      IMPIPCST=NTPIPCST;IMGTLCPC=0
      DO 7380 M = 1,MM
      MOBFNCST(M)=LCMCST1(M)+MPIPCST(M)+MGTLCPCS(M)+LCMCST3(M)+
$LCMCST2(M)+LCMTRANS(M)
      IOBFNTOT=IOBFNTOT+MOBFNCST(M)
      ILCMCST=ILCMCST+LCMCST1(M)+LCMCST3(M)+LCMCST2(M)
      IMPIPCST=IMPIPCST+MPIPCST(M)
      IMGTLCPC=IMGTLCPC+MGTLCPCS(M)
 7380 CONTINUE
      IXCST=IXCST+ILCMCST
      IXPIP=IXPIP+IMPIPCST
      IXPART=IXPART+IMGTLCPC
C
C     RETURN
C
      GO TO 107
C
```

22. Subsection 7600, Objective Function Tables. This part of the program contains the logic to print out the objective tables near the end of the program output. See lines 14730 through 17210.

```
14730C  SUBSECTION 7600
14740C
14750C  OUTPUT ROUTINES -- OBJECTIVE FUNCTION TABLES
14760C
14770C COMPLETE ENGINE MAINTENANCE COST
14780C
14790 7400 IF(IP.EQ.1) GO TO 8100
14800  IPG = IPG+1
14810  PRINT 7410,IPG
14820 7410 FORMAT(1H1,T21,"OBJECTIVE FUNCTION",T53,"PAGE ",I4)
14830  PRINT 7405
14840 7405 FORMAT("0",T14,"COMPLETE ENGINE MAINTENANCE COSTS")
14850  PRINT 7403
14860 7403 FORMAT("0",/,T29,"* * * * FACTORS * * * *")
14870  PRINT 7415,LFCYC,LFCYC
14880 7415 FORMAT("0",T13,"ENGINE    * ",I2,"/  REM/REP AV.BASE ",
14890$ "AV.DEP. ",1X,I2,"-YEAR")
14900  PRINT 7420,ISIMYRS
14910 7420 FORMAT(" ",T13,"REMVLS      ",I3," CST/REM CST/REM ",
14920$  "CST/REM  COSTS")
14930  PRINT 7425
14940 7425 FORMAT(" ",T13,"------ -------- ------- ------- -------",
14950$"  -------")
14960  PRINT 7430,NGTOTRT,ELTOTRT,NBSCST,NLCRRIST
14970 7430 FORMAT("0","BASE REMVLS ",1X,I4,1X,F8.4,3X,I5,18X,I7)
14980  PRINT 7435,NENGBASE,ELCBASE,NAVBCST,LNAVBCST
14990 7435 FORMAT("0"," BASE   RTS  ",I4,1X,F8.4,10X,I6.
15000$10X,I7)
15010  PRINT 7440,NENGNRTS,ELCNRTS,NOPCST,NLCDPCST
15020 7440 FORMAT("0"," DEPOT NRTS  ",I4,1X,F8.4,18X,I6.2X,
15030$I7)
15040  PRINT 7445,LCTECST
15050 7445 FORMAT("0",/,"GRAND TOTAL",41X,I8)
15060C
15070C
15080C
```

```
7500 PRINT 7510
7510 FORMAT("0")
 PRINT 7515
7515 FORMAT("0",T28,"OBJECTIVE FUNCTION")
 PRINT 7520
7520 FORMAT("0",T20,"MODULE MAINTENANCE COST WITH")
 PRINT 7530,LFCYC,LFCYC
7530 FORMAT("0",2X,"       MODULE  ",3X,"TOTAL NRTS    ",I2,"/",
$"     DEPOT ",3X,"TOTAL ",I2," YRS")
 PRINT 7540,ISIMYRS
7540 FORMAT(" ","ITEM",1X,"NOMENCLATURE",3X,"MOD REMOVLS    ",
$1X,I3," COST FACTOR",3X,"  DEPOT")
 PRINT 7550
7550 FORMAT(" ","----",1X,14("-"),1X,11("-"),1X,6("-"),1X,
$11("-"),1X,12("-"),//)
 DO 7570 M=1,MM
 PRINT 7580,M,MODULE(M),MNRTSWTH(M),FACNRTSW(M),MDPCST(M),
$LCMCST3(M)
7580 FORMAT(" ",I3,1X,A15,I7,4X,F8.4,2X,I8,4X,I9)

7570 CONTINUE
 PRINT 7590,LCTMCST3
7590 FORMAT("0",T48,"TOTAL ",I9////)
C
C
C
C
7600 PRINT 7610
7610 FORMAT(1H0,T28,"OBJECTIVE FUNCTION")
 PRINT 7620
7620 FORMAT("0",T21,"COMPLETE ENGINE PIPELINE COSTS")
 PRINT 7630
7630 FORMAT("0",1X,"DAILY DEMAND RATE    N R T S   B A S E",
$"     PIPELINE  STK LIST   TOTAL")
 PRINT 7640,MONUTR,IDCR
7640 FORMAT(" ","REM/1000EH ",I2,"/",I5,2X,"RATE PIPE RATE PIPE",3X,
$"QUANTITY    PRICE      COST")
 PRINT 7650
7650 FORMAT(" ",8("-"),2X,10("-"),1X,2("---- ---- "),
$2X,8("-"),2X,8("-"),1X,7("-"))
 PRINT 7660,ERKFH,ELCDDR,ENRTSPC,NDRIPE,RRTSPC,
$NBPIPE,ERIPEQTY,NSLP,NTPIPCST
7660 FORMAT("0",F7.4,2X,F10.7,1X,F5.1,I4,1X,
$F5.1,1X,I3,3X,F8.3,2X,I8,1X,I7)
C
C  OBJECTIVE FUNCTION -- MODULE MAINTENANCE COSTS
C
```

```
 7700 IPG = IPG+1
 7720 PRINT 7730,IPG
 7730 FORMAT("1",T28,"OBJECTIVE FUNCTION",18X,"PAGE ",I4)
  PRINT 7740
 7740 FORMAT("0",T22,"MODULE MAINTENANCE COSTS-ALONE")
  PRINT 7750,LFCYC,LFCYC,LFCYC
 7750 FORMAT("0",5X,"TOTAL NRTS *",I2,"/    DEPOT",
$"   TOTAL BASE  *",I2,"/   BASE",4X,"TOTAL ",I2," YRS")
  PRINT 7760,ISIMYRS,ISIMYRS
 7760 FORMAT(" ","ITEM MOD REMVLS   ",I3," COST FACT",
$" MOD REMVLS   ",I3," COST FACT  DEPOT&BASE")
  PRINT 7770
 7770 FORMAT(" ","---- ",10("-"),1X,6("-"),1X,9("-"),1X,
$10("-"),1X,5("-"),1X,9("-"),1X,12("-"),//)
  DO 7780 M=1,MM
  PRINT 7790,M,MTNRTS(M),FACMNRTS(M),MDPCST(M),
$MRTS(M),FACMRTS(M),MBSCST(M),LCMCST(M)
 7790 FORMAT(" ",I3,4X,I4,3X,F8.4,1X,I7,5X,I4,
$3X,F8.4,1X,I6,4X,I8)
 7780 CONTINUE
  PRINT 7795,LCTMCST
 7795 FORMAT("0",T56,"TOTAL ",I9,///)
C
C  OBJECTIVE FUNCTION --MODULE PIPELINE COSTS
C
  GO TO 7825
  IPG = IPG+1
 7810 PRINT 7820,IPG
 7820 FORMAT("1",T28,"OBJECTIVE FUNCTION",13X,"PAGE ",I4)
 7825 PRINT 7830
 7830 FORMAT("0",T26,"MODULE PIPELINE COSTS")
  PRINT 7840
 7840 FORMAT("0",6X,"DAILY DEMAND RATE   ",
$"NRTS   BASE   PIPELINE   MODULE COST PER")
  PRINT 7850,MONUTR,IDCR
 7850 FORMAT(" ","ITEM REM/1000FH*",I2,"/",I5,"   PIPE",
$"   PIPE    QTY/MOD     PRICE   MODULE")
  PRINT 7860
 7860 FORMAT(" ","----",1X,8("-"),2X,"---------- ",6("-"),
$" ----- --------- ------- ---------",//)
 DO 7870 M=1,MM
  PRINT 7880,M,FRKFM(M),DLCMDDR(M),MDPIPE(M),MBPIPE(M),
$PIPEQTYM(M),MSLP(M),MPIPCST(M)
 7880 FORMAT(" ",I3,2X,F7.4,2X,F10.7,2X,I4,
$3X,I4,2X,F9.5,1X,I7,1X,I8)
 7870 CONTINUE
  PRINT 7890,MTPIPCST
 7890 FORMAT("0",T53,"TOTAL ",I8)
```

```
C
      PRINT 7900
 7900 FORMAT("0",/,T18,"TRANSPORTATION COSTS")
C
      PRINT 7910,LFCYC,LFCYC
 7910 FORMAT("0",T24,"  NRTS      * ",I2,"/ TRANSPT  "
     $,I2,"-YEAR")
      PRINT 7920,ISIMYRS
 7920 FORMAT(" ","ITEM NOMENCLATURE   REMOVALS        ",
     $I3," CST/REM     COSTS")
      PRINT 7930
 7930 FORMAT(" ","---- ----------------- ---------  ----------",
     $ " ------- ---------")
      PRINT 7940,NENGNRTS,ELCNRTS,NTRCST,LCNTRANS
 7940 FORMAT("0"," ENG COMPLETE ENG.",5X,I4,3X,F8.4,1X,I7,2X,I7)
      DO 7950 M=1,MM
      PRINT 7960,M,MODULE(M),MINRTS(M),FACMNRTS(M),MTRCST(M)
     $,LCMTRANS(M)
 7960 FORMAT(" ",I3,2X,A15,3X,I4,3X,F8.4,I8,I9)
 7950 CONTINUE
      PRINT 7970,LCMTTRAN
 7970 FORMAT("0",T34,"MODULES TOTAL  ",I7)
      PRINT 7980,LCGTTRAN
 7980 FORMAT("0",T36,"GRAND TOTAL  ",I7)
C
C OBJECTIVE FUNCTION -- PARTS REPLACEMENT COSTS
C
 8000 DO 8010 M = 1,MM
C HEADINGS
      IF (M.EQ.01) GO TO 8005
      IF (M.LT.04) GO TO 8015
      IF (M.EQ.05) GO TO 8015
      IF (M.GT.06) GO TO 8015
 8005 IPG = IPG+1
      PRINT 8020,IPG
 8020 FORMAT("1",T50,"PAGE ",I4)
      PRINT 8030
 8030 FORMAT(" ",T13,"LIFE-LIMITED PARTS ",
     $"REPLACEMENT COSTS")
      PRINT 8040,LFCYC
 8040 FORMAT(" ",T20,"FOR ",I2,"-YEAR LIFE CYCLE")
 8015 PRINT 8045,MODULE(M)
 8045 FORMAT("0",T24,">>>",A15)
      PRINT 8050
 8050 FORMAT("0","PART",6X,"PART",6X,"TOTAL ",
```

```
&"SCHED  SCHED RMVL  UNIT    TOTAL")
  PRINT 8060,ISIMYRS,LFCYC,LFCYC
8060 FORMAT(" "," NO.",6X,"NAME",6X,"RMVL(",I3,"YR)",
&"    (",I2,"YR)   PRICE    ",I2,"-YR")
  PRINT 8065
8065 FORMAT(1H ,4("-"),1X,14("-"),1X,11("-"),2X,10("-"),
&1X,5("-"),2X,7("-"),//)
  DO 8070 J = JF(M),JF(M+1)-1
  PRINT 8080,J,PART(J),JTPSCHD(J),RLCPSCHD(J),
&JSLP(J),JTLCPCST(J)
8080 FORMAT(" ",I3,2X,A14,4X,I4,5X,F9.5,1X,
&I7,1X,I8)
8070 CONTINUE
  PRINT 8090,MGTLCPCS(M)
8090 FORMAT("0",T36,"MODULE SUBTOTAL",1X,I8,///)
8010 CONTINUE
  PRINT 8095,NGTLCPCS
8095 FORMAT("0",T32,"ENGINE GRAND TOTAL ",I9)
C
8100 IPG = IPG + 1
  IF(IAVG.GT.1) GO TO 8104
  PRINT 8102,IPG
8102 FORMAT("1",T28,"OBJECTIVE FUNCTION",10X,"PAGE ",I4)
  GO TO 8108
8104 PRINT 8105,IPG
8105 FORMAT("0",T28,"OBJECTIVE FUNCTION",10X,"PAGE ",I4)
8108 PRINT 8110
8110 FORMAT(" ",T33,"SUMMARY")
  PRINT 8115
8115 FORMAT("0",T30,"F100PW100(F15)")
  PRINT 8120,XDATE,FTIME,LTIME
8120 FORMAT("0","DATE ",A8,T53,"TIME ",F5.2," SEC ",I2)
  PRINT 8125
8125 FORMAT("0",T8,"* * * MAINTENANCE COSTS * * *      P",
&"IPE   TRANS")
  PRINT 8130,LFCYC
8130 FORMAT(" ",T8," ALONE   ALONE    WITH",T41," LINE",
&"    PORT   PARTS  ",1X,I2,"-YEAR")
  PRINT 8135
```

```
8135 FORMAT(" ","ITEM     BASE   DEPOT   DEPOT   TOTALS",
&"   COSTS   COSTS   COSTS     COSTS")
 PRINT 8140
8140 FORMAT(" ","----   ------   ------   ------",
&"  -------   ------   ------   ------   ---------")
 PRINT 8145,NTCBSCST,NLCDPCST,LCTECST,NTPIPCST,LCNTRANS,
&NOBFNCST
8145 FORMAT(1H0," ENG",4X,I7,9X,I7,I9,
&I8,I8,10X,I8,//)
 DO 8150 M = 1,MM
 PRINT 8155,M,LCMCST2(M),LCMCST1(M),LCMCST3(M),
&LCST4(M),MPIPCST(M),LCMTRANS(M),MGTLCPCS(M),MOBFNCST(M)
8155 FORMAT(1H ,I4,I8,I8,I8,I9,I8,I8,I8,I10)
C TOTALS FOR MODULES
8150 CONTINUE
PRINT 8160,LCTMCST2,LCTMCST1,LCTMCST3,LCTMCST4,
&MTPIPCST,LCMTTRAN,NGTLCPCS,IOBFNTOT
8160 FORMAT(1H0,"MODTOT",I6,I8,I8,I9,I8,I8,I8,I10)
C
 IF(IAVG.GT.1) GO TO 8170
 IOBFNGT=0
 IOBFNGT=IOBFNTOT+NOBFNCST
 IAOBGTOT=IAOBGTOT+IOBFNGT
8170 PRINT 8180,ILCLCLT,IXPIPCST,LCGTTRAN,IMGTLCPC,
&IOBFNGT
8180 FORMAT(1H0,"GRAND TOTALS",I11,I8,I8,I8,I8,I10)
C RETURN
C
 IF(IAVG.GT.1) GO TO 8190
 GO TO 108
8190 IF(ISMAX.EQ.1) GO TO 9997
 PRINT 8195,IXCST,IXPIP,MXTRAN,IXPART,IAOBGTOT
8195 FORMAT("0","SEED TOTALS ",4(2X,I9),3X,I10)
 GO TO 9995
C
```

23. <u>Subsection 8200, Screen, NRTS, Removals Per 1000 FH Summary</u>. This part of the program contains the output logic for the summary showing screens applied, NRTS produced, and removals obtained from the program run.

```
C SUBSECTION 8200
C
C  OUTPUT --  SCREEN, NRTS, REM/1000FH SUMMARY
C
 8200 PRINT 8205
 8205 FORMAT("0")
C
 8208 PRINT 8210
C
C
 8210 FORMAT("0",T15,"* ","SCREEN, NRTS RATE & ",
$"REMOVALS PER 1000 FH"," *")
  PRINT 8220
 8220 FORMAT(" ",T32,"SUMMARY")
  PRINT 8225,XDATE,FTIME,LTIME
 8225 FORMAT(1H0,"DATE ",A8,T52,"TIME ",F5.2," SEC ",I2)
  PRINT 8230,BLKAVS
 8230 FORMAT("0",T49,A19)
  PRINT 8235,KPSCRN
 8235 FORMAT(" ",T19,A8,2X,"* I N I T I A L *",
$"       * * F I N A L * *")
  PRINT 8240
 8240 FORMAT(" ","  ITEM              ",
$"SCREEN       NRTS         REM/         ",
$"NRTS         REM/")
  PRINT 8250
 8250 FORMAT(" ","  NAME",11X,"INTERVAL",3X,"RATE %",
$"     1000 FH.     RATE %     1000 FH.")
  PRINT 8260
 8260 FORMAT(" ",13("-"),4X,8("-"),3X,
$6("-"),4X,8("-"),4X,6("-"),4X,8("-"))
  PRINT 8270,BNRTSPC,BRKFH,ENRTSPC,ERKFH
 8270 FORMAT("0","COMPLETE ENG.",15X,F6.2,
$4X,F8.4,4X,F6.2,4X,F8.4,//)
  DO 8280 M = 1,MM
  PRINT 8290,MODULE(M),MSCRN(M),BNRTSPC(M),
$BRKFH(M),FNRTSPC(M),FRKFH(M)
 8290 FORMAT(" ",A14,3X,I7,4X,F6.2,4X,F8.4,4X,
$F6.2,4X,F8.4)
 8280 CONTINUE
 PRINT 8295,MRULE
 8295 FORMAT(1H0,"RULE OF X WAS ",I2,/)
C
  IF(ISMAX.EQ.ISDRUN) GO TO 8299
C
  PRINT 8298
```

```
8298 FORMAT(1H0,15("*"),10X,"NEXT SEED RUN",10X,15("*"))
C
8299 IF(ISMAX.NE.ISDRUN) GO TO 1020
C
C
      IF(IAVG.EQ.0) GO TO 9992
C
      PRINT 8297,ENRTSPCT,ERKPHT
8297 FORMAT("0",T15,"SEED TOTALS ",2X,"NRTS % ",F6.2,2X,
$"REMOVALS ",F8.4)
C
      GO TO 9997
C
C    OUTPUT  --  ACTUARIAL INPUT FACTORS
C
8300 IPG = IPG+1
      PRINT 8310,INDATA,IPG
8310 FORMAT("1",T2,A5,6X,"ACTUARIAL INPUT",
$" FACTORS",15X,"PAGE ",I4)
      PRINT 8315,ENGINE
8315 FORMAT("0",T10,"ENGINE ",A15)
      PRINT 8320,NDPIPE,NBPIPE,NSLP
8320 FORMAT("0","DEPOT PIPE IS",1X,I3,2X,"BASE PIPE IS",I3,2X,
$"LIST PRICE IS ",I7)
      PRINT 8330,NDPCST,NBSCST
8330 FORMAT(" ","DEPOT MAINT COST IS",2X,I8,2X,
$"BASE MAINT COST IS",3X,I5,///)
      DO 8420 M = 1,MM
      PRINT 8430,MODULE(M)
8430 FORMAT("0",T17,A14)
      PRINT 8400,MDPIPE(M),MBPIPE(M),MSLP(M)
8400 FORMAT("0","DEPOT PIPE IS",1X,I3,2X,"BASE PIPE IS",I3,
$2X,"LIST PRICE IS ",I7)
      PRINT 8405,MDPCST(M),MBSCST(M)
8405 FORMAT(" ","DEPOT MAINT COST IS",2X,I8,
$2X,"BASE MAINT COST IS",3X,I5)
      PRINT 8410,MTRCST(M),MBSEPMH(M)
8410 FORMAT(" ","TRANSPORT COST ",I8,5X,
$"MANHOUR DATA ",I8)
      PRINT 8440
8440 FORMAT("0","PART   PART",10X,
$"CONVERT  MAX. SHAPE  SCALE        UNIT")
      PRINT 8450
8450 FORMAT(" "," NO.   NAME",11X,
$"RATIO   TIME PARAM  PARAM        PRICE",//)
      DO 8460 J = JF(M),JF(M+1)-1
      PRINT 8470,J,PART(J),R(J),MOT(J),
$SHP(J),JSCL(J),JSLP(J)
8470 FORMAT(" ",I5,2X,A14,1X,F6.3,1X,
$I6,1X,F5.2,1X,I7,3X,I8)
8460 CONTINUE
8420 CONTINUE
C
```

```
C RETURN
C
GO TO 9998
C
8600 BLKAVG = ">>> * AVERAGE * <<<"
C
  MUSET=0;MUDT=0;MTMT=0;MTOTRT=0;MSCRT=0;ENRTSPC=EANRTS
  ERKEH=EAFH
  DO 8605 M=1,MM
  MTOTR(M)=0
  FRKEH(M)=FKFH(M)/FLOAT(ISMAX)
  FNRTSPC(M)=FNRTS(M)/FLOAT(ISMAX)
  MUSE(M)=IFIX((FLOAT(MAUSE(M))/FLOAT(ISMAX))+.5)
  MUSET=MUSET+MUSE(M)
  MUD(M)=IFIX((FLOAT(MAUD(M))/FLOAT(ISMAX))+.5)
  MUDT=MUDT+MUD(M)
  MTM(M)=IFIX((FLOAT(MATM(M))/FLOAT(ISMAX))+.5)
  MTMT=MTMT+MTM(M)
  MSCR(M)=IFIX((FLOAT(MASCR(M))/FLOAT(ISMAX))+.5)
  MSCRT=MSCRT+MSCR(M)
  MTOTR(M)=MUSE(M)+MUD(M)+MTM(M)+MSCR(M)
  MTOTRT=MTOTRT+MTOTR(M)
8605 CONTINUE
C
  IOBFNTOT=0;LCTMCST=0;LCTMCST3=0;LCTECST=0
  NGTLCPCS=0;LCTMCST4=0;LCTMCST2=0;LCMTTRAN=0
  MTPIPCST=0;NOBFNCST=0;LCTMCST1=0;LCGTTRAN=0
LCNTRANS=IFIX((FLOAT(NXTRAN)/FLOAT(ISMAX))+.5)
NLCDPCST=IFIX((FLOAT(NXDEPO)/FLOAT(ISMAX))+.5)
NTCBSCST=IFIX((FLOAT(NXBASE)/FLOAT(ISMAX))+.5)
LCTECST=NLCDPCST+NTCBSCST
  NTPIPCST=IFIX((FLOAT(NXPIP)/FLOAT(ISMAX))+.5)
  NOBFNCST=LCTECST+NTPIPCST+LCNTRANS
C
  DO 8610 M=1,MM
  LCMTRANS(M)=0
  LCMCST(M)=0
  MOBFNCST(M)=0
  LCST4(M)=0
  DCST3=0.0
  DCST3=FLOAT(LXCST3(M))/FLOAT(ISMAX)+.5
  LCMCST3(M)=IFIX(DCST3)
  LCTMCST3=LCTMCST3+LCMCST3(M)
  LCMCST1(M)=IFIX((FLOAT(LXCST1(M))/FLOAT(ISMAX))+.5)
  LCTMCST1=LCTMCST1+LCMCST1(M)
```

```
      LCMCST2(M)=IFIX((FLOAT(LXCST2(M))/FLOAT(ISMAX))+.5)
      LCTMCST2=LCTMCST2+LCMCST2(M)
      LCST4(M)=LCMCST1(M)+LCMCST3(M)+LCMCST2(M)
      LCTMCST4=LCTMCST4+LCST4(M)
      LCMCST(M)=LCMCST2(M)+LCMCST1(M)
      LCTMCST=LCTMCST+LCMCST(M)
      MPIPCST(M)=IFIX((FLOAT(MXPIP(M))/FLOAT(ISMAX))+.5)
      MGTLCPCS(M)=IFIX((FLOAT(MXGPCS(M))/FLOAT(ISMAX))+.5)
      LCMTRANS(M)=IFIX((FLOAT(MXTRCST(M))/FLOAT(ISMAX))+.5)
      LCMTTRAN=LCMTTRAN+LCMTRANS(M)
      MOBFNCST(M)=LCST4(M)+MPIPCST(M)+MGTLCPCS(M)+LCMTRANS(M)
      MTPIPCST=MTPIPCST+MPIPCST(M)
      NGTLCPCS=NGTLCPCS+MGTLCPCS(M)
 8610 CONTINUE
      IOBFNTOT=LCTMCST4+MTPIPCST+NGTLCPCS+LCMTTRAN
 LCGTTRAN=LCMTTRAN+LCNTRANS
 IOBFNGT=0
 IOBFNGT=IOBFNTOT+NOBFNCST
 ILCMCST=0
 ILCMCST=LCTMCST4+LCTECST
 IMGTLCPC=0;IMPIPCST=0
 IMGTLCPC=NGTLCPCS
 IMPIPCST=MTPIPCST+NTPIPCST
C
C
      NGTOTRT=0;NGUSE1T=0;NGUSE2T=0;NGTM2T=0;NGTM1T=0
      DO 8615 K=1,KLAST
      NGTOTR(K)=0
      NGUSE1(K)=IFIX((FLOAT(NGU1(K))/FLOAT(ISMAX))+.5)
      NGUSE1T=NGUSE1T+NGUSE1(K)
      NGUSE2(K)=IFIX((FLOAT(NGU2(K))/FLOAT(ISMAX))+.5)
      NGUSE2T=NGUSE2T+NGUSE2(K)
      NGTM2(K)=IFIX((FLOAT(NGT2(K))/FLOAT(ISMAX))+.5)
      NGTM2T=NGTM2T+NGTM2(K)
      NGTM1(K)=IFIX((FLOAT(NGT1(K))/FLOAT(ISMAX))+.5)
      NGTM1T=NGTM1T+NGTM1(K)
      NGTOTR(K)=NGUSE1(K)+NGUSE2(K)+NGTM2(K)+NGTM1(K)
      NGTOTRT=NGTOTRT+NGTOTR(K)
 8615 CONTINUE
C
      IAVG=0
      GO TO 9993
C
C
      9000 CONTINUE
C
```

24. Input Data. The input data is found in lines 19090 through 21070. It is divided into several sections and each is discussed below.

a. Names and Indices. This section names each module identified in the program and each part, including dummy parts, that are used in the output. The names attempt to correlate the actual part names where possible.

b. Actuarial, Pipeline, and Cost Data. This section assigns values where necessary to compute costs, NRTS, and pipeline data for the program. The Design Maintenance Concept is the source for most of the actuarial and cost figures. A Weibull failure rate is assumed to compute the scale (JSCL) and shaping (SHP) parameters for the parts. All of the variables should be defined and can be found in Chapter VIII, Program Variables.

```
19090C  INPUT DATA * * * * * * * * * * * * * * * * * * * * * * * * * * *
19100C
19110C  * * * 4.7F100 * 25 APR 79 * * * * * * * * * * * * * * * * * * * * * *
19120C  PART NUMBERS 301, 302 MOVED FROM FAN TO ACC1 SINCE THESE
19130C  ARE EXTERNAL TO FAN AND CAUSE NO FAN REMOVAL.  EFF 29JAN79
19140C - NAMES AND INDICES -
19150C
19160   INDATA = "DATA1"
19170   ENGINE = "F100PW100(F15)"
19180   MODULE(1) = "700 AUGMENTOR"
19190   MODULE(2) = "100 ACC1 WLL"
19200   MODULE(3) = "300 FAN"
19210   MODULE(4) = "400 CORE"
19220   MODULE(5) = "500 H P TURB"
19230   MODULE(6) = "600 FAN DR TUR"
19240   MODULE(7) = "800 GEARBOX"
19250   MODULE(8) = "900 ACC2 WOLL"
19260C
```

```
19270  PART(1) = "700 AUGM DUMMY"
19280  PART(2) = "100 ACC1 DUMMY"
19290  PART(3) = "110 FNT FN DCT"
19300  PART(4) = "111 R FN DCT"
19310  PART(5) = "301 VANE"
19320  PART(6) = "302 VANE"
19330  PART(7) = "300 FAN DUMMY"
19340  PART(8) = "303 1STG DISK"
19350  PART(9) = "304 2STG DISK"
19360  PART(10) = "305 3STG DISK"
19370  PART(11) = "306 1STG SEAL"
19380  PART(12) = "307 FRNT SEAL"
19390  PART(13) = "308 REAR SEAL"
19400  PART(14) = "309 RETAINER"
19410  PART(15) = "310 2STG SEAL"
19420  PART(16) = "400 CORE DUMMY"
19430  PART(17) = "401 4STG SEAL"
19440  PART(18) = "402 5STG SEAL"
19450  PART(19) = "403 6STG SEAL"
19460  PART(20) = "404 7STG SEAL"
19470  PART(21) = "405 8STG SEAL"
19480  PART(22) = "406  9STG SEAL"
19490  PART(23) = "407 10STG SEAL"
19500  PART(24) = "408 11STG SEAL"
19510  PART(25) = "409 12STG SEAL"
19520  PART(26) = "410 13STG SEAL"
19530  PART(27) = "411 4STG DISK"
19540  PART(28) = "412 5STG DISK"
19550  PART(29) ="413 6STG DISK"
19560  PART(30) = "414 7STG DISK"
19570  PART(31) = "415 8STG DISK"
19580  PART(32) = "416 9STG DISK"
19590  PART(33) = "417 10STG DISK"
19600  PART(34) = "418 11STG DISK"
19610  PART(35) = "419 12STG DISK"
19620  PART(36) = "420 13STG DISK"
19630  PART(37) = "421 REAR SHAFT"
19640  PART(38) = "500 HPT DUMMY"
19650  PART(39) = "501 1STG DISK"
19660  PART(40) = "502 2STG DISK"
19670  PART(41) = "503 2STG DISK"
19680  PART(42) = "504 1STG FPLT"
19690  PART(43) = "505 1STG RPLT"
19700  PART(44) = "600 PDT DUMMY"
19710  PART(45) = "601 3STG DISK"
19720  PART(46) = "602 4STG DISK"
19730  PART(47) = "603 4STG DISK"
19740  PART(48) = "800 GBOX DUMMY"
19750  PART(49) = "900 ACCS DUMMY"
19760C
```

```
19770  JF(1) = 1
19780  JF(2) = 2
19790  JF(3) = 7
19800  JF(4) = 16
19810 JF(5) = 38
19820  JF(6) = 44
19830  JF(7) = 48
19840  JF(8) = 49
19850  JF(9) = 50
19860C
19870C - ACTUARIAL, PIPELINE, AND COST DATA -
19880C
19890C - - ENGINE - -
19900C
19910  BENRTSPC = 4.7;    NDPCST = 15801;    NDPIPE = 42
19920  BERKFH = 4.7;      NBSCST = 161;      NBPIPE = 4
19930  NBTESTMH = 12;  NSLP = 1700000;  NTRCST = 5000; BMHCST = 12.0
19940C
19950C - - AUGMENTOR - -
19960C
19970  MOT(1) = 1000000
19980  R(1)    = 1.0
19990  ALOC(1) = 0.0
20000  SHP(1)  = 2.0
20010  JSCL(1) = 974
20020  BNRTSPC(1) = 9.0;   MDPCST(1) = 1753;    MDPIPE(1) = 22
20030  BRKFH(1)    = 1.09004;  MBSCST(1) = 775;MBPIPE(1) =  4
20040                     MSLP(1) = 360000
20050  MTRCST(1) = 2066;          MBSEPMH(1) = 30
20060C
20070C - - ACCESSORIES 1  WITH LIFE LIMITS - -
20080C
20090  DATA(MOT(I),I=2,6)/1000000,1250,1250,1000,1200/
20100  DATA(R(I),I=2,6)/1.0,1.6,1.6,1.6,1.6/
20110  DATA(ALOC(I),I=2,6)/5*0.0/
20120  DATA(SHP(I),I=2,6)/2.0,4*5.0/
20130  DATA(JSCL(I),I=2,6)/5*990000/
20140  DATA(JSLP(I),I=2,6)/20000,6209,9053,3890,828/
20150  BNRTSPC(2) = 0.0;   MDPCST(2) = 846;     MDPIPE(2) = 4
20160  BRKFH(2) = 0.00000;  MBSCST(2) = 846;    MBPIPE(2) = 2
20170                     MSLP(2) = 67426
20180  MTRCST(2) = 0;              MBSEPMH(2) = 23
20190C
```

```
20200C - - INLET FAN - -
20210C
20220   DATA(MOT(I),I=7,15)/1000000,3400,3300,3000,5*10000/
20230   DATA(R(I),I =7,15)/1.0,8*2.20/
20240   DATA(ALOC(I),I=7,15)/9*0.0/
20250   DATA(SHR(I),I=7,15)/2.0,8*5.0/
20260   DATA(JSCL(I),I=7,15)/4033,8*990000/
20270   DATA(JSLP(I),I=7,15)/2500,7310,6054,5016,
20280&1848,1106,1347,744,2045/
20290   BNRTSPC(3) =   56.0;     MDPCST(3) =  3200;    MDPIPE(3) = 23
20300   BRKEH(3) = 0.2632;       MBSCST(3)=    839;    MBPIPE(3) =  4
20310                            MSLP(3) = 177060
20320   MTRCST(3) = 888;               MBSEPMH(3) = 78
20330C
20340C - - CORE - -
20350C
20360   DATA(MOT(I),I=16,37)/1000000,9400,17500,8200,11000,5*5600,
20370&2*15000,13000,21000,5500,7500,8300,15550,14000,10500,13500,15500/
20380   DATA(R(I),I=16,37)/1.0,21*2.20/
20390   DATA(ALOC(I),I=16,37)/22*0.0/
20400   DATA(SHR(I),I=16,37)/2.0,21*5.0/
20410 DATA(JSCL(I),I=16,37)/12915,21*990000/
20420   DATA(JSLP(I),I=16,37)/5500,1093,1280,1424,1163,
20430&1742,1118,3292,3308,3360,5283,4708,3893,8134,6764,
20440&4448,8549,4441,8448,4641,8486,9793/
20450   BNRTSPC(4) =   85.0;     MDPCST(4) = 6025;    MDPIPE(4) = 36
20460   BRKEH(4) = 0.0822;       MBSCST(4) =    675;   MBPIPE(4) =  8
20470                            MSLP(4) = 704000
20480   MTRCST(4) = 2013;               MBSEPMH(4) = 213
20490C
20500C - - HIGH PRESSURE TURBINE - -
20510C
20520   DATA(MOT(I),I=38,43)/1000000,8100,9806,1800,1800,1800/
20530   DATA(R(I),I=38,43)/1.0,5*2.20/
20540   DATA(ALOC(I),I=38,43)/6*0.0/
20550   DATA(SHR(I),I=38,43)/2.0,5*5.0/
20560   DATA(JSCL(I),I=38,43)/18054,5*990000/
20570   DATA(JSLP(I),I=38,43)/5500,14553,19416,30475,4077,98/
20580   BNRTSPC(5)  =  70.0;     MDPCST(5) = 1507;    MDPIPE(5) = 29
20590   BRKEH(5) = 0.0588;       MBSCST(5) =  850;    MBPIPE(5) =  3
20600                            MSLP(5) = 131028
20610   MTRCST(5) = 423;               MBSEPMH(5) = 158
20620C
20630C - - FAN DRIVE TURBINE - -
20640C
```

```
      DATA(MOT(I),I=44,47)/1000000,3300,3000,30000/
      DATA(R(I),I=44,47)/1.0,3*2.20/
      DATA(ALOC(I),I=44,47)/4*0.0/
      DATA(SHP(I),I=44,47)/2.0,3*5.0/
      DATA(JSCL(I),I=44,47)/6274,3*990000/
      DATA(JSLP(I),I=44,47)/1716,8024,6502,15017/
      BNRTSPC(6) = 53.0;       MDPCST(6) =    3020;  MDPIPE(6) = 19
      BRKEH(6) = 0.1692;       MBSCST(6) =     536;  MBPIPE(6) =  5
                               MSLP(6) = 169000
      MTRCST(6) = 1107;               MBSEPMH(6) = 113
C
C - - GEARBOX - -
C
      MOT(48) = 2000
      R(48) = 1.6
      ALOC(48) =  0.0
      SHP(48) = 2.0
      JSCL(48) = 5944
      JSLP(48) = 684
      BNRTSPC(7) = 77.0   ;  MDPCST(7) = 1068;     MDPIPE(7) = 16
      BRKEH(7) = 0.1786;     MBSCST(7) =  299;     MBPIPE(7) =  2
                             MSLP(7) = 28000
      MTRCST(7) = 200;              MBSEPMH(7) = 13
C
C - - ACCESSORIES 2  WITHOUT LIFE LIMITS - -
C
      MOT(49) = 1000000
      R(49) = 1.0
      ALOC(49) = 0.0
      SHP(49) = 2.0
      JSCL(49) = 338
      JSLP(49) = 0
      BNRTSPC(8) = 0.0;      MDPCST(8) = 124;        MDPIPE(8) = 0
      BRKEH(8) = 3.1443;     MBSCST(8) =    0;         MBPIPE(8) = 1
                             MSLP(8) = 0
      MTRCST(8) = 0;                MBSEPMH(8) = 16
C
C
C
      GO TO 8900
 9999 STOP
      END
$:ENDJOB
```

VII. Program Variables

The program variables used in OMENS are alphabetized and listed below with a brief explanation of each immediately following the variable.

ALOC(J) - Weibull location parameter; in most cases this parameter will be zero.

AMONREM - screen interval defined in equivalent months of life remaining.

BENRTSPC - initial base engine NRTS percent.

BERKFH - initial base level engine removals per 1000 flying hours.

BNRTSPC(M) - base level initial NRTS percent by module.

BOTTOM - total NRTS alone plus total NRTS with engine plus total base removals for each module.

BRKFH(M) - base removals per 1000 flying hours.

DCONVR - conversion factor for changing months of utilization into daily demand rate.

DEPPC(M) - depot level removal percent by module.

DLCMDDR(M) - depot life cycle module daily demand rate.

EAFH - engine average flying hours.

EANRTS - engine average NRTS rate.

ELCBASE - engine life cycle base removals.

ELCDDR - engine life cycle daily demand rate.

ELCNRTS - engine life cycle NRTS removals.

ENGINE - name of engine.

ENRTSPC - engine final NRTS percent (output).

ENRTSPCT - engine seed totals NRTS percent.

EPIPEQTY - engine pipeline quantity.

ERKFH - output engine removals per 1000 flying hours.

ERKFHT - engine seed total removal / 1000 FH.

ERTSPC - percent engine base removals.

FACMNRTS(M) - final life cycle NRTS alone (not Rule of X Policy) by module.

FACMRTS(M) - final life cycle base removals remaining at base by module.

FACNRTSW(M) - final life cycle Rule of X Policy NRTS removals by module.

FKFH(M) - see average removals per 1000 FH by module.

FNRTS(M) - see average NRTS percent by module.

FNRTSPC(M) - final NRTS percent by module.

FRKFH(M) - base final removals per 1000 flying hours by module.

FRKFHC(M) - total final removals per 1000 flying hours by module.

FRKFHD(M) - depot final removals per 1000 flying hours by module.

FTIME - time in hours and minutes (in clock minutes).

I - a counter.

IAOBGTOT - seed total of MOBFNCST(M).

ICLOCK - clock for aging.

IDCR - integer value of variable DCONVR.

ILCMCST - engine and module grand total maintenance costs.

IMGTLCPC - engine and module grand total parts costs.

IMPIPCST - grand total pipeline costs for engine and module.

INDATA - name of data set being used (internal to program).

IOBFNAX - seeds total NGTOTRT.

IOBFNTOT - module grand total maintenance, pipeline, and parts costs.

IP - print indicator; long run = 0, short run = 1.

IPG - page number.

IRPTPRD - input report period width.

ISCRN - screen constant.

ISDRUN - # of seed runs; counts up to ISMAX.

ISIMPRD - total number of simulation years in program run.

ISIMYRS - total # of simulation years.

ISMAX - total # of seed runs done.

ISSCRN - integer value of the percent of MOT screen.

ITIME - machine-supplied time during program run.

IWS - integer working storage in warmup.

IXCST - seed total of ILCMCST.

IXPART - seed total of IMGTLCPC.

IXPIP - seed total of IMPIPCST.

J - part number.

JF(N) - number of first part in Mth module.

JJ - number of parts.

JPART(J) - removal code for parts.

JPMOT(J) - maximum operating time assigned by part.

JSCL(J) - Weibull scale parameter; this is similar to an actuarial life expectancy.

JSCR(J) - screen removal for part J.

JSCRT - grand total parts screened removals.

JSLP(J) - stock list price for part J.

JTLCPCST(J) - total life cycle parts cost for each part.

JTM(J) - MOT removal for part J.

JTMT - grand total parts max time removals.

JTOL - tolerance interval constant.

JTOLR(J) - tolerance removal for part J.

JTOLRT - grand total parts tolerance removals.

JTOTR(J) - total number of removals for part J.

JTOTRT - grand total parts removals for all causes.

JTPSCHD(J) - total scheduled part removals by module for the entire simulation period.

JTTF(J) - time til failure of part J.

JTTL(J) - time til life limit of part J.

JUDEP(J) - usage screened to depot removal for part J.

JUDEPT - grand total parts usage screened to depot removals.

JUSE(J) - usage removal for part J.

JUSET - grand total parts usage removals.

K - report period counter.

K1 - report period time.

K3 - time remaining this report period.

KK - # of report periods.

KPI - constant or percent indicator.

KLAST - last report period.

KPV(M) - screen for modules 1 through 8.

KS - 0 implies standard seed, 1 implies random.

KW - 1 implies warmup, 0 implies none.

LCMCST(M) - life cycle maintenance cost, both depot and base, by module.

LCMCST1(M) - depot life cycle maintenance costs of modules returned to depot alone.

LCMCST2(M) - base life cycle maintenance costs by module.

LCMCST3(M) - depot life cycle maintenance costs with Policy by module for modules returned to depot with engine.

LCST4(M) - total of LCMCST(M) and LCMCST3(M) by module.

LCTECST - life cycle total engine maintenance cost for depot and base.

LCTMCST - total LCMCST(M) for all modules.

LCTMCST1 - modular totals of LCMCST1.

LCTMCST3 - modular totals for all LCMCST3(M).

LCTMCST4 - total of LCST4(M) for all modules.

LFCYC - life cycle period in years.

LTIME - time in clock seconds.

LXCMST - seed total life cycle maintenance costs.

LXCMST3 - seed total life cycle maintenance costs at depot.

LXCMST4 - seed totals of LXCMST and LXCMST4.

LXCST(M) - seed total life cycle maintenance costs by module.

LXCST1(M) - seed totals of LCMCST1(M).

LXCST2(M) - seed totals of LCMCST2(M).

LXCST3(M) - seed totals of LCMCST3(M).

LXCST4(M) - seed totals of LCMCST4(M).

LXECST - seed total engine life cycle maintenance cost.

M - module number, used as counter in DO loops.

MASCR(M) - seed screened totals by module.

MASCRT - seed totals for screened module.

MATM(M) - seed time totals by module.

MATMT - seed totals for module time removals.

MAUD(M) - seed U-Dep totals by module.

MAUDT - seed totals for U-Dep module removals.

MAUSE(M) - seed usage totals by module.

MAUSET - seed totals for usage module removals.

MBPIPE(M) - base pipeline in days by module.

MBSCST(M) - module base maintenance cost.

MDPCST(M) - module depot maintenance cost.

MDPIPE(M) - depot pipeline in days by module.

MGTLCPCS(M) - module grand total life-cycle parts cost for each module.

MINF - minimum JTTF(J).

MINL - minimum JTTL(J).

MJSCRT(M) - total JSCR(J) for all J in module M.

MJTMT(M) - total JTM(J) for all J in module M.

MJTOLRT(M) - total JTOLR(J) for all J in module M.

MJTOTRT(M) - total JTOTR(J) for all J in module M.

MJUDEPT(M) - total JUDEP(J) for all J in module M.

MJUSET(M) - total JUSE(J) removals for all J in module M.

MM - number of modules.

MMC - multiple module counter for engine.

MMM - module counter.

MNRTSWTH(M) - total Rule of X Policy removals by module.

MNRWTHTL - total MNRTSWTH(M) removals for all modules.

MOBFNCST(M) - total LCST4(M) plus MPIPCST(M) plus MGTLCPCS(M) for each module.

MOD(M) - module removal code.

MODSCR(M,K) - total modules removed due to screened out parts by module and by report period.

MODTM1(M,K) - total time module removals for a single scheduled part by report period and by module.

MODTM2(M,K) - total time module removals (for at least one scheduled part) by report period and by module.

MODTOTR(M,K) - total module removals for all causes by module and by report period.

MODULE(M) - name of module.

MODUSE1(M,K) - total usage module removals for a single part by report period and by module.

MODUSE2(M,K) - total usage module removals (for more than one part) by report period and by module.

MONUTR - monthly utilization rate in flying hours.

MOT(J) - input life limit for part J in either TOT or cycles as appropriate.

MPC - multiple parts counter for module.

MPIPCST(M) - total pipeline cost per module.

MR3 - # of "rule of 3" modules with removals.

MRTS(M) - module base removals remaining at base.

MRTST - total module RTS removals.

MRULE - X value for Rule of X Policy.

MSCHNRTS(M) - module scheduled NRTS.

MSCHNRTT - total module scheduled NRTS.

MSCR(M) - module screen.

MSCRN(M) - screen interval for the Mth module.

MSCRNRTS(M) - module screened removals by module.

MSCRNRTT - total of MSCRNRTS(M) for all modules.

MSCRT - total screened modules.

MSLP(M) - stock list price by module.

MTM(M) - module max time removal.

MTMT - total of module max time removals.

MTNRTS(M) - total NRTS removals, not Rule of X Policy, by module.

MTNRTST - total MINRTS(M) for all modules.

MTOTR(M) - number of modules removed this period.

MTOTRT - total number of modules removed.

MTPIPCST - total MPIPCST(M) for all modules.

MTSCR(M) - total MODSCR(M,K) by module for all report periods.

MTTM1(M) - total MODTM1(M,K) by module for all report periods

MTTM2(M) - total MODTM2(M,K) by module for all report periods.

MTTOTR(M) - total MODTOTR(M,K) removals for all report periods by module.

MTUSE1(M) - total MODUSE1(M,K) for all report periods by module.

MTUSE2(M) - total MODUSE2(M,K) for all report periods by module.

MUD(M) - module usage to depot removal.

MUDT - total MUD(M) for all modules.

MULTF - counter of multiple part failures.

MULTL - counter of multiple parts scheduled.

MUNRTS(M) - usage removals by module.

MUNRTST - total MUNRTS(M) for all modules.

MUSE(M) - module usage removals.

MUSET - total MUSE(M) for all modules.

MUSNRTS(M) - usage screened removals by module.

MUSNRTST - total MUSNRTS(M) for all modules.

MXGPCS(M) - seed total parts costs by module.

MXOKNRTS(M) - by module, total shipped to depot as part of the Rule of X Policy but not needing repair.

MXOKNRTT - total MXOKNRTS(M) for all modules.

MXPIP(M) - seed total pipeline costs by module.

MXPIPT - seed total pipeline costs.

MXSCHNRT(M) - by module, scheduled Rule of X Policy removals.

MXSCHNTT - total MXSCHNRT(M) removals for all modules.

MXSCRNRT(M) - by module, screened Rule of X Policy removals.

MXSCRNTT - total MXSCRNRT(M) for all modules.

MXTOT - seed totals for module removals summary.

MXTRAN - seed totals for transportation costs.

MXTRCST(M) - seed totals by module for transportation costs.

MXUNRTS(M) - by module, total usage Rule of X removals.

MXUNRTST - total MXUNRTS(M) for all modules.

MXUSNRTS(M) - by module, total usage-screen Rule of X removals.

MXUSNRTT - total MXUSNRTS(M) for all modules.

NBPIPE - engine base pipeline in days.

NBSCST - base engine maintenance cost.

NDPCST - engine depot maintenance cost.

NDPIPE - engine depot pipeline in days.

NENGBASE - engine base removals.

NENGNRTS - engine base removals that were NRTS as Rule of X Policy.

NENGTOT - engine total removals.

NERC - engine removal code.

NGTLCPCS - total MGTLCPCS(M) for all modules.

NGTM1(K) - engine grand total single module removals by report period.

NGTM1T - total of NGTM1(K) removals for all report periods.

NGTM2(K) - engine removals by report period for more than one module with at least one scheduled module.

NGTM2T - total of NGTM2(K) removals for all K periods.

NGTOTR(K) - engine total removals; all causes by report period.

NGTOTRT - grand total NGTOTR(K) for all K periods.

NGUSE1(K) - engine usage removals by report period for a single module.

NGUSE1T - total engine usage removals for a single module.

NGUSE2(K) - total usage engine removals by report period.

NGUSE2T - total of NGUSE2(K) for all report periods.

NN - number of entries in JF array (equals MM+1).

NOBFNCST - complete engine total maintenance and pipeline costs.

NSLP - engine stock list price.

NTPIPCST - engine total pipeline cost.

NXBASE - engine seed totals base costs.

NXBFN - seeds total base alone maintenance costs.

NXDEPO - engine seed totals depot costs.

NXPCST - seeds total parts costs.

NXPIP - engine seed totals pipeline costs.

NXTRAN - engine seed totals transportation costs.

PART(J) - name of Jth part.

PIPEQTYM(M) - pipeline quantity by module.

R(J) - ratio of TOT to EFH or to cycles per flying hour.

RFACTOR - R factor to convert ratios to engine flying hours.

RLCPSCHD(J) - total scheduled part removals by module for the life cycle.

SCL(J) - scale parameter for Weibull.

SCLE - part scale parameter.

SCRINEFH - screen converted to engine flying hours.

SDTYP - seed type (random or standard).

SEED - random number seed.

SIMYRS - number of simulation years for program run.

SHP(J) - Weibull shape parameter (or = 1) 1 implies exponential; 1 implies removal rates which increase with age.

TOP - total NRTS alone plus total NRTS with engine for each module.

TOTPC(M) - total percent removals for cause repaired at depot.

TTF - time til failure.

XDATE - calendar date by month, day, and year.